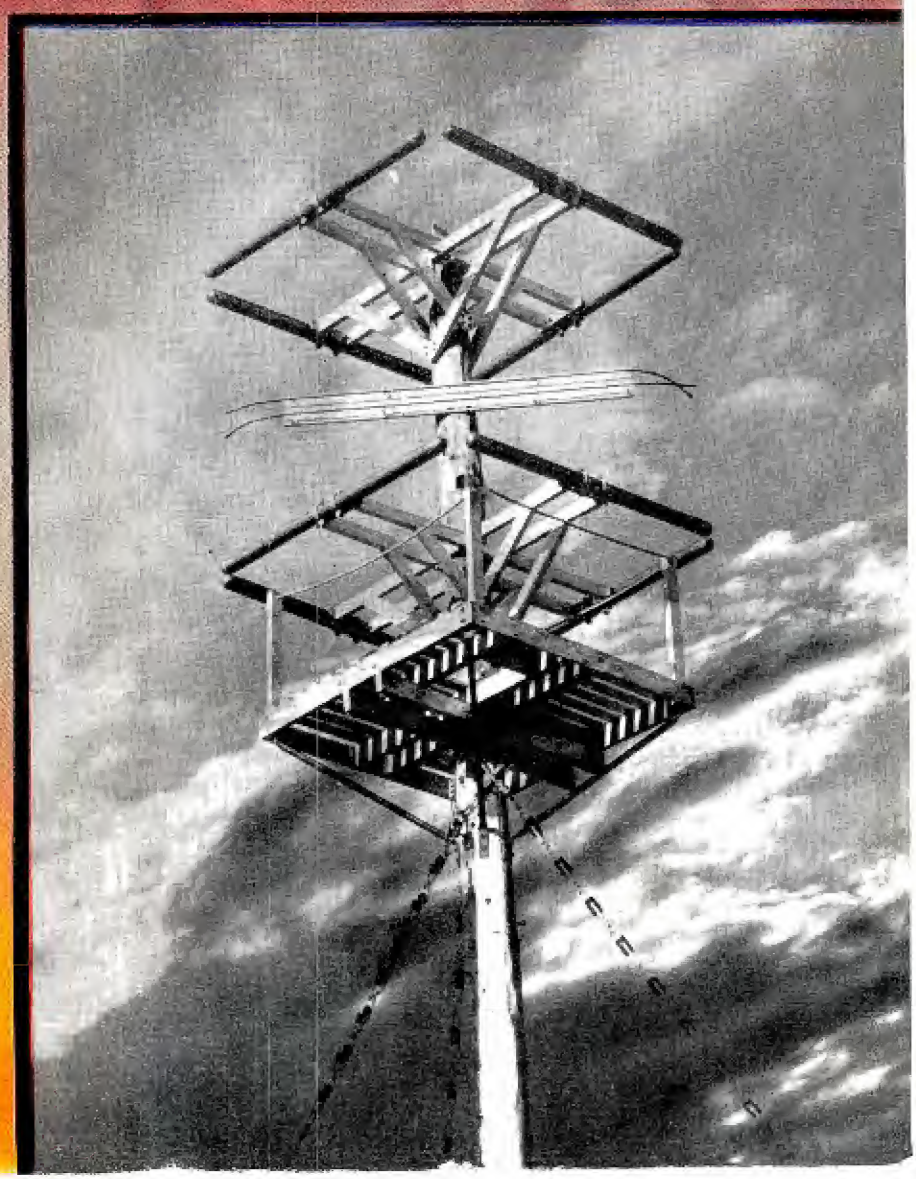
COMMUNICATIONS

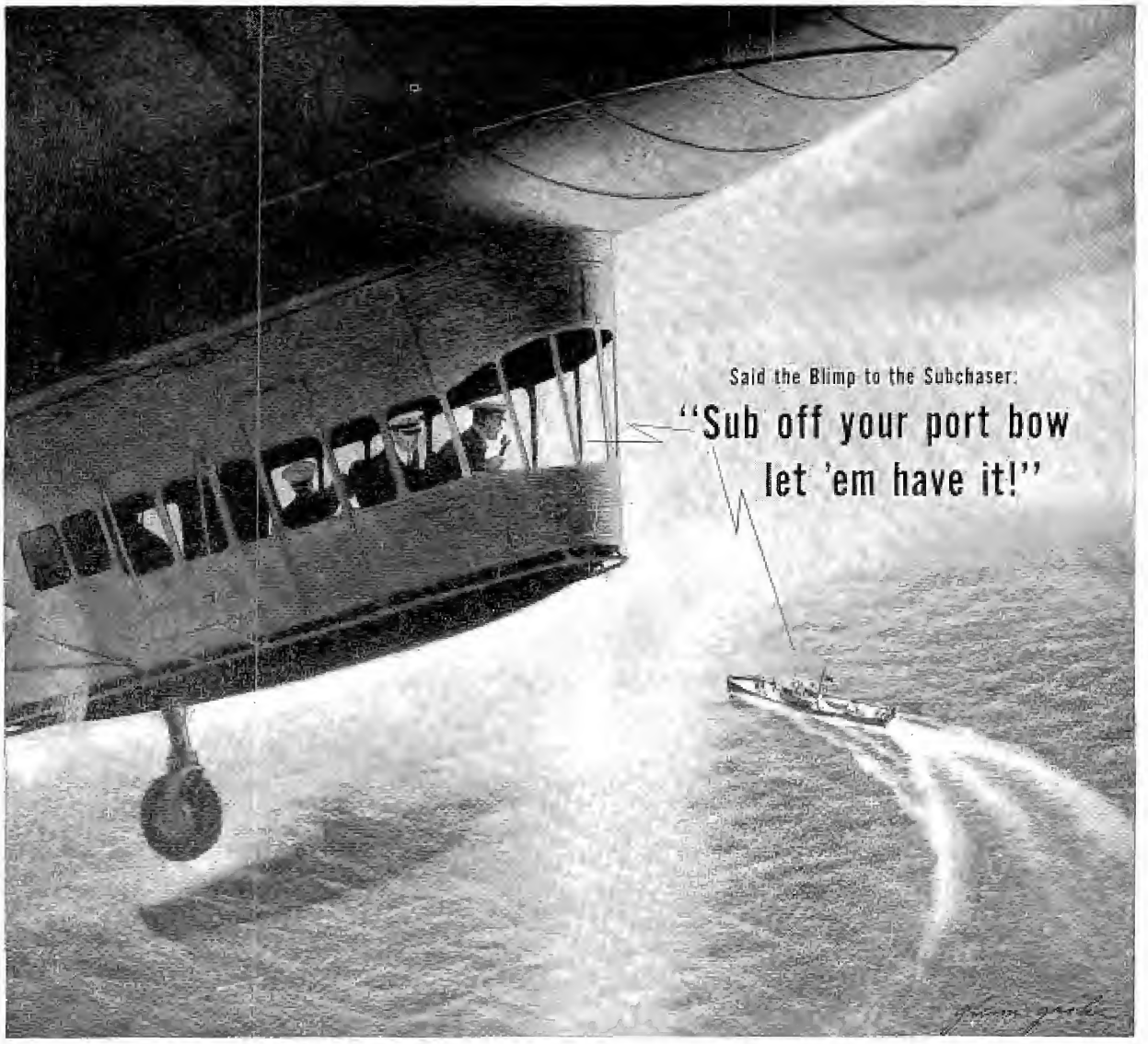


BROADCAST PROGRAM
FAILURE ALARM

GENERATOR AND
MOTOR MAINTENANCE

INTERFERENCE SUPPRESSION
IN A-M AND F-M SYSTEMS

AUGUST
1942



They work together better...
because they can talk together

The blimp
From the advantage of height
Spots the shark-like shadow
Slinking below the surface . . .

And passes the word
To the Subchaser
Which wheels with roaring motors
To lay the deadly pattern
Of thunderous depth-bombs . . .

An underwater barrage
That crushes the lurking sub
As a well-aimed rock
Will finish a snake.

That's *teamwork*
Teamwork made possible
By the radiotelephone.

Modern communication equipment
Designed and manufactured
By I. T. & T. associate companies
Is helping Uncle Sam
Coordinate his forces
On land, sea and in the air.

The broad, peacetime experience
Of I. T. & T.
In the field of communications
Is proving its value
In time of war.

INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION *67 Broad St., New York, N. Y.*

IT&T

Associate Manufacturing Companies in the United States
International Telephone & Radio Manufacturing Corporation
Federal Telegraph Company

LEWIS WINNER, Editor
F. WALEN, Associate Editor

We See...

AGAIN THE WPB HAMMER HAS FALLEN . . . this time on motors. From now on . . large motors of any kind . . . used or new . . . are not available for other than war or other essential civilian purposes. Thus, what's on hand, will have to be used to do the job, indefinitely. While this maintenance procedure has been a voluntary practice with many for quite a while, it now becomes a "must practice" for everyone. A campaign to project this emergency plan throughout the nation will soon swing into action. COMMUNICATIONS, in this issue, contributes to this effort, with the publication of a specially prepared maintenance article by M. C. Cisler of General Electric.

For many months, the WPB has not been too lenient in the granting of priority assistance to would-be purchasers of new motors, unless the needs were for the military or essential civilian. Applicants were asked to first make a thorough search for second-hand motors which might serve the purpose. There are well over a million second-hand motors above one horsepower in the country today. These are primarily in the hands of second-hand dealers, in plants whose operations have been curtailed because of the war production program, on machines which have been taken off the assembly line because they were not suitable for war work, and elsewhere where abandoned industrial facilities are found.

The Surplus Used Equipment Section of the Conservation Division is compiling a list of at the rate of 1000 motors a day, according to type, and expect to have eventually a record of 300,000 motors. In order to have a complete file showing all available used motors, the WPB has asked owners of motors to communicate with the Conservation Division, Used Equipment Section. All motors distributed from this pool will be allocated through the Motor and Control Section.

In purchasing motors, the WPB requests that simplification be the major consideration. There are several types of units that can be used for many applications. The one with the least "frills," should be specified. See the charts in this issue. They will serve as valuable guides.—L. W.

COMMUNICATIONS

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Member of Audit Bureau of Circulations.

AUGUST, 1942

VOLUME 22 NUMBER 8

COVER ILLUSTRATION

A new cubical antenna for aural transmission in a high power television transmitter.

(Photo courtesy General Electric Company)

Published Monthly by the Bryan Davis Publishing Co., Inc.

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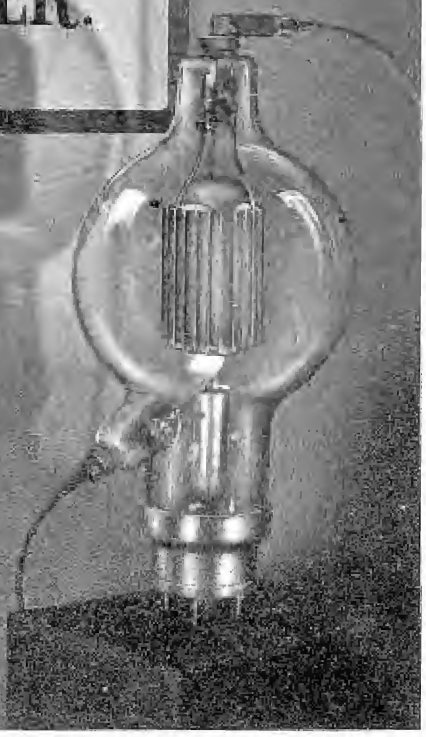
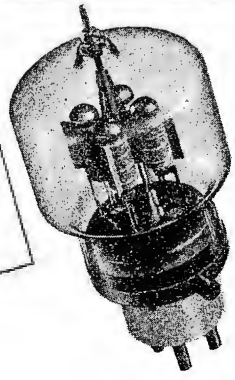
TO STAY BEST . . .
IT MUST BE EVER BETTER.



Ahead in the Past

This radical shape... plus unusual performance capabilities started the parade in 1934.



Ahead Today

The multiunit triode is today in fact what many thought could only exist in theory.

Everlastingly seeking improvements in the performance capabilities of the vacuum tube. That's the creed of the personnel in the Eimac shops. That's why you find Eimac tubes in the key sockets of practically every new development in the field of electronics, why communications men throughout the world have come to measure results in terms of the performance capabilities of Eimac tubes. This high standard of excellence was deliberately planned at Eimac . . . and is being deliberately maintained despite the rigors of wartime production.

You've found Eimac ahead in the past . . . they're ahead today . . . and you'll find them still ahead in the future

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BROADCAST PROGRAM FAILURE ALARM

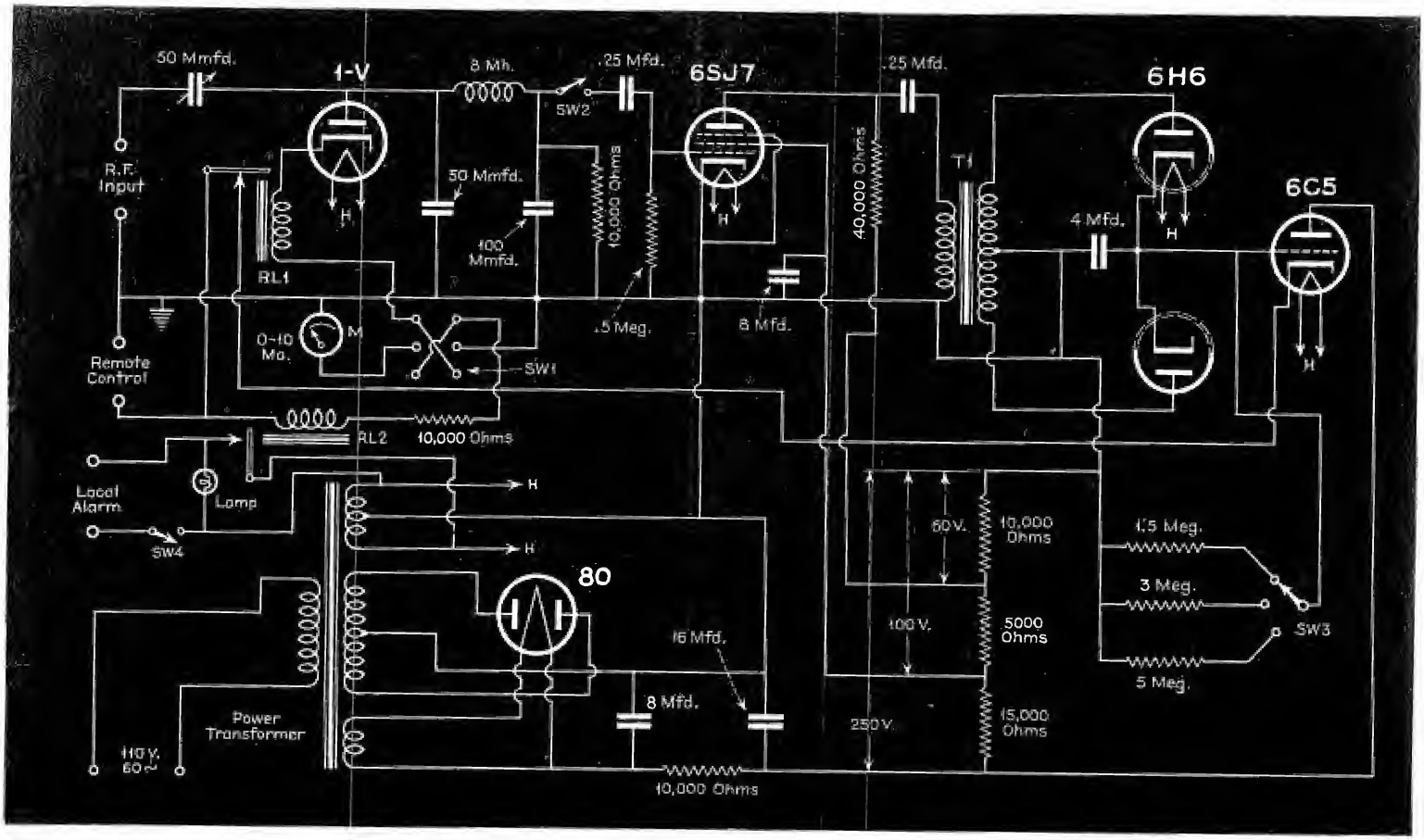


Figure 1

An Unusual Automatic Monitoring Device Providing a Visual-Aural Alarm When The Carrier, Program Line or Program Fails

by ELWIN J. O'BRIEN

Assistant Professor of Electrical Engineering, University of North Dakota

THE decrease in the technical staffs of broadcast stations has made it necessary to depend more on mechanical devices to help monitor the programs. While the purpose of such units is basically simple, the necessary development does not unfortunately follow these simple lines. There are many problems inherent to broadcast circuits that call for study and application of, for instance, time elements, as in the case of the mechanical alarm device developed for stations in our area.

This device is a new tube-operated program alarm, which provides a visual-aural alarm when the carrier of the transmitter, the program line or the program fails. The carrier and program line alarm is instantaneous while the program alarm has an adjustable time

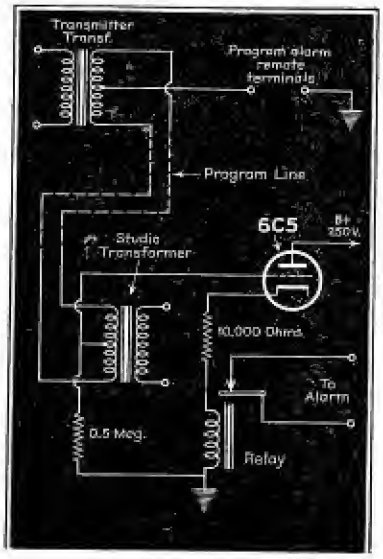


Figure 2

delay which prevents operation during normal short pauses in program continuity.

The Circuit

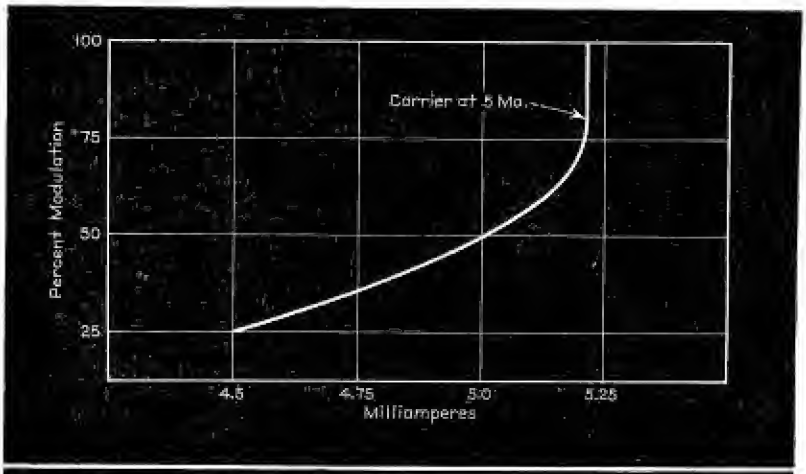
In Figure 1 we have schematic wiring diagram of the device. The modulated carrier is rectified in the first tube and after passing through a limiting stage is again rectified to provide the control voltage for the relay tube. The limiter makes the d-c component of voltage across the RC circuit independent of percentage modulation.

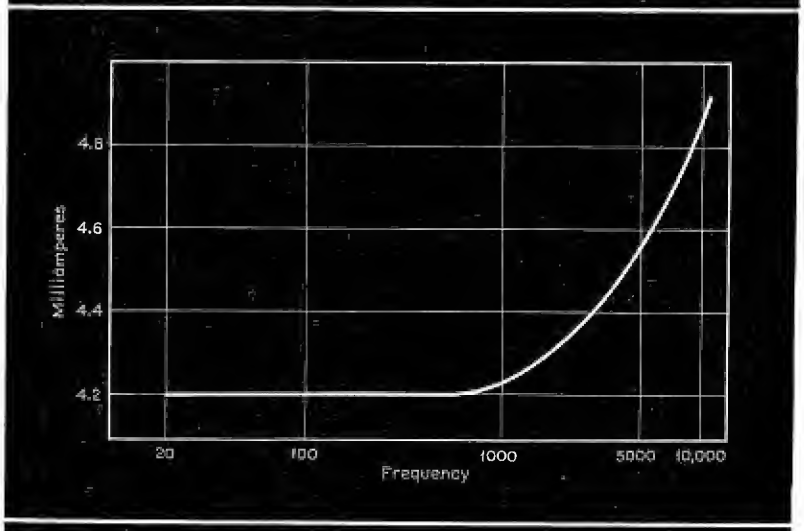
Relay Control

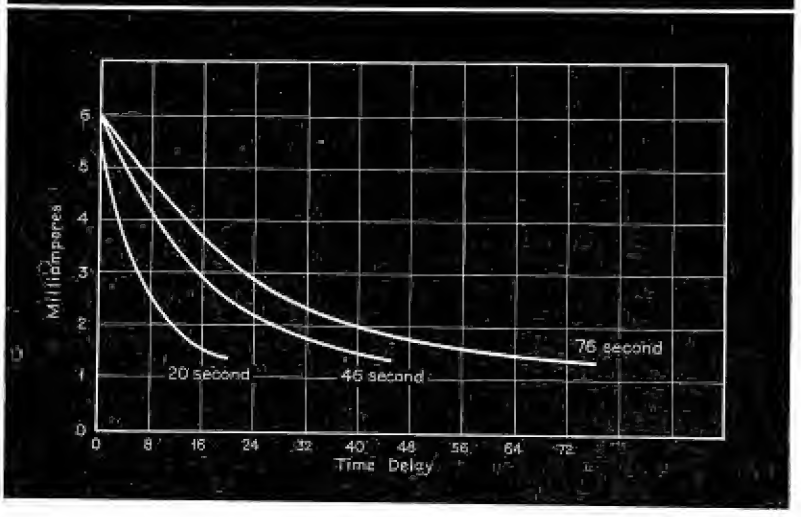
The grid circuit of the relay control tube is connected across the time delay RC network. The cathode current with zero grid voltage is approximately 1.4 milliamperes. The voltage across the delay network, on modulation, is applied to the grid and causes about 5.5 milliamperes to flow. When the program stops, the condenser discharges slowly through the diode load resistor and the relay tube grid voltage decreases at an exponential rate with a consequent decrease in the cathode current. The relay opens when the current drops to 1.4 milliamperes giving a visual-aural alarm. In the first tube of the unit the rectified modulated carrier - current holds a relay closed. The contact of this relay (RL_1) is in the cathode circuit of the visual-aural relay tube. A carrier failure will, therefore, open relay (RL_1) which in turn opens the cathode circuit, causing the visual-aural alarm relay (RL_2) to operate.

Remote Indicator

The connections for remote indication are shown in Figure 2. The d-c







Figures 3, 4 and 5

voltage on the line controls the operation of the remote electron relay which is a duplicate of the relay at the transmitter. If the two relays are adjusted for the same spring tension the time of operation of the remote unit will be the same as the control relay.

If the program line is cut the remote signal operates immediately, while the transmitter unit will follow the delay curve. A carrier break operates both alarms simultaneously.

The 0-10 ma meter can be used to either measure the rectified carrier current or to indicate the alarm relay cur-

(*Continued on page 38*)

INTERFERENCE SUPPRESSION IN A-M AND F-M

by HERBERT J. REICH

Department of Electrical Engineering, University of Illinois

THE most important advantages of frequency modulation over amplitude modulation in radio communication result from the greater suppression of undesired carriers and noise. The following analysis of interference suppression in amplitude- and frequency-modulation systems has been used by the author for several years in teaching modulation and detection to senior electrical engineering students. Although it is neither complete nor outstanding in mathematical rigor, it does appear to have some merit in explaining a phenomenon that is often quite puzzling to the student.

INTERFERENCE FROM UNDESIRED CARRIER

Let $E_k \sin 2\pi f_k t$ be the desired unmodulated carrier voltage impressed upon the input of the receiver and $E_i \sin 2\pi f_i t$ be an interfering carrier voltage, also assumed to be unmodulated. Then the resultant voltage impressed upon the receiver input is

$$e = E_k \sin 2\pi f_k t + E_i \sin 2\pi f_i t \quad ..(1)$$

As shown in the appendix, Eq. (1) may be transformed into

$$e = E \sin (2\pi f_k t - \phi) \quad .....(2)$$

where $E = E_k\sqrt{1 + 2h \cos 2\pi f_{ki} t + h^2}$ .....(3)

$$h = E_i/E_k \quad .....(4)$$

$$f_{ki} = f_k - f_i \quad .....(5)$$

$$\phi = \tan^{-1} \frac{h \sin 2\pi f_{ki} t}{1 + h \cos 2\pi f_{ki} t} \quad .....(6)$$

Since both E and ϕ vary with time, Eq. (2) shows that the impressed voltage may be considered to have the frequency of the desired carrier and to be modulated simultaneously in amplitude and in phase. Although both types of modulation are complicated functions of time, it may be shown that the fundamental frequency of each is f_{ki}, the difference between the frequencies of the two carriers. Figure 1 shows the wave form of the sum of two sinusoidal voltages of equal amplitude and 3:2 frequency ratio. The amplitude modulation is evident at a glance. The phase

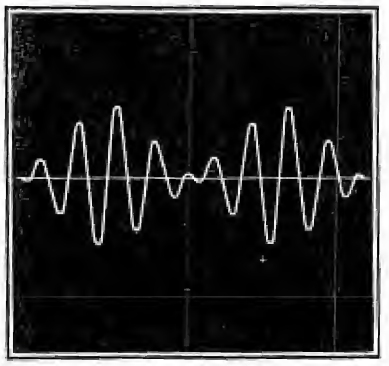


Figure 1

modulation can be observed by noting that the points at which the curve crosses the axis are not evenly spaced.

A-M SYSTEM

In a properly tuned a-m receiver, the detector responds only to amplitude modulation. Figure 2 shows the manner in which E, the amplitude of the resultant input voltage, varies with time at constant amplitude of desired carrier voltage and several values of interfering carrier voltage. By comparison with the dotted curve it can be seen that the fundamental frequency at which the desired carrier is modulated by the undesired carrier is the difference between the two carrier frequencies. The curve corresponding to $E_i = E_k$ shows that when the two carrier input voltages have equal amplitude, the desired carrier is fully modulated by the undesired carrier. As E_i is reduced, the degree of modulation is reduced, and is always equal to E_i/E_k, the ratio of the strengths of the two carriers. The ratio of the amplitude of the beat-frequency output of the detector to the desired a-f output is equal to the ratio of the modulation factor corresponding to the interfering carrier to the modulation factor corresponding to the desired audio-frequency signal. This is the interference-to-signal ratio:

$$N/S = E_i/ME_k \quad .....(7)$$

If the desired carrier is fully modulated by the desired audio-frequency signal, this ratio reduces to E_i/E_k.

F-M SYSTEM

In an f-m receiver, the purpose of the limiter is to remove amplitude modulation from the discriminator input. Since the limiter cannot function completely when the amplitude modulation of the impressed voltage approaches 100 per cent, it can be seen from Figure 2 that amplitude modulation of the desired carrier by an interfering carrier, can be completely removed only when the strength of the interfering carrier is somewhat less than that of the desired carrier. When the amplitude modulation is completely removed, E of Eq. (2) is constant at the input to the discriminator. Analysis of Eq. (6) indicates that ϕ varies periodically with time and that the fundamental frequency at which ϕ varies is the difference between the frequencies of the two carriers. Figure 3 shows the manner in which ϕ varies during one difference-frequency cycle for several values of E_i/E_k.

The symmetry of the curves of Figure 3 is such that ϕ may be expressed as a series of sine terms:

$$\phi = \phi_1 \sin 2\pi f_{ki} t + \phi_2 \sin 4\pi f_{ki} t + \phi_3 \sin 6\pi f_{ki} t + \ldots \quad (8)$$

and Eq. (2) becomes

$$e = E \sin \left(2\pi f_k - \sum_{n=1}^{\infty} \phi_n \sin 2n\pi f_{ki} t \right) \quad .....(9)$$

Equation (9) is that of a phase-modulated wave[1] modulated simultaneously at frequencies equal to the difference in the frequencies of the two carriers and at harmonics of the difference frequency. When E_i/E_k is less than 0.5, all terms of Eq. (8) except the first are small and for the sake of simplicity will be assumed to be negligible. It may then also be assumed that ϕ_1 is equal to the maximum value of the curve in Figure 3 corresponding to the given value of E_i/E_k. Equation (9) then reduces to

$$e = E \sin (2\pi f_k t - \phi_1 \sin 2\pi f_{ki} t) \ldots (10)$$

It has been shown by Roder and others[1] that a frequency-modulated volt-

(*Continued on page* 16)

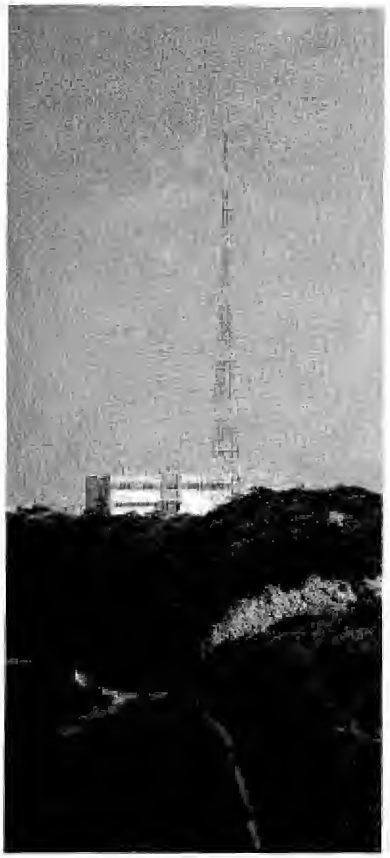
PORTABLE TELEVISION PICKUPS*

by HARRY R. LUBCKE

Director of Television, Don Lee Broadcasting System, Hollywood

THE routine of portable television programing may be termed "applied" television engineering. The preceding is hardly more than a byplay of words, but is intended to convey the impression of an engineering technique evolved to put a program across regardless of extenuating circumstances. The emphasis is not on engineering, but on the program; with engineering as one of the tools used in accomplishing the program.

A portable television pickup staff has somewhat the problem of the young parent; inducing the off-spring to correctly perform at the right time. The public never knows what may have occurred before program time, nor what happens after it, and it cares less. Thus, all activities are directed toward establishing the best insurance designed to accomplish peak technical performance during the program period.



The Mt. Lee television installation. This is the receiving location for all portable pickups.

There are several factors which contribute to the desired end. These may be recited as: methodical preparation, adequate time allowed for preparation, careful testing, an experienced crew having the "feel" of the equipment, technical-programing coordination, adequate policing to prevent damage to equipment during the program, and "luck."

The basis of methodical preparation lies in the formulation and use of suitable lists and forms. At the start of our portable pickup endeavors a list of necessary items was formulated, down to pieces of rope, masking tape, screws, nails, and a hammer. Upon starting on a job, the equipment is checked off against the list. Experience dictates changes and the lists are frequently revised. Large metal tool cases have been found convenient to carry parts, tools, and lenses; one case for each classification.

The principal form employed has been our "MOBILE TELEVISION PICKUP WORK SHEET. Nine outline headings tabulate the information required to accomplish the pickup. The information is secured in a number of ways. It is desirable to give the managing executive and his electrician on the premises where the event occurs a background of television requirements. When time permits, copies of the form are mailed to these men for their education (or "mystification.") The head of the portable television department then surveys the site, securing the major portion of the information for the form by inspection and questioning of the above-mentioned personnel.

Inspection of the form will reveal that numerous sections can be answered in consultation at the site. Thus, the television engineer may include two heavy-current electric heaters and an a-c voltmeter among his equipment. Placing the same on the line removes all doubts as to the regulation of the line and the ability of the (usually hidden) fuses to pass the thirty ampere load. Should this test not be performed at this time, it is then performed at the preliminary or propagation test, or finally, at the very start of operations as many hours before program time as possible.

Equipment always carried by the survey engineer comprises a photometer (or Weston Brightness meter), field glasses and a photographic camera. The former is used to test the installed illumination, as at a prize fighting ring, or the effect of grand-stand shadows on a playing field. The field glasses are used to ascertain if a line-of-sight path exists from the program site to the home television station. Beam television transmitting and receiving equipment operating on a frequency of 324 megacycles (less than one meter) as used by the Don Lee Broadcasting System requires substantially a line-of-sight transmission path. The camera is used to take photographs of the premises pertinent to the scene of action, the proposed points of installation and as an additional check on the illumination of the scene. It is not difficult to calibrate a given film and camera to the sensitivity of the television system, and the photographs thus secured are a definite guide and aid in evaluating existing conditions and in suggesting required changes.

After the initial survey, which may be a week or even a month in advance of a new program or series of programs, "adequate time for preparation" and "careful testing" call for a "propagation test if the relay distance is over five miles. This entails installing the portable transmitter and an antenna at the program site and sending a "dummy

*At the May, 1942, SMPE Convention in Hollywood Mr. Lubcke presented a paper on this subject. In this presentation appears this paper plus other related data and illustrations specially prepared for COMMUNICATIONS by Mr. Lubcke.

picture" back to the home station. The latter is comprised of a group of vertical black and white bars and is produced by a small self-contained portable oscillator operating on a frequency of 94,500 cycles. Six white and six black bars are produced. By noting the evenness of the boundary from black to white the amount of "noise" on the relay propagation channel is indicated. Unevenness is caused by interference bursts occurring near the time of the high frequency synchronizing pulse of sufficient amplitude to mis-synchronize the receiver scanning oscillator.

With relay equipment of given power and sensitivity the only method of increasing the signal to noise ratio on a pickup is to vary the placement and the type of transmitting and receiving antennas. The rapidity and effectiveness with which a desirable combination can be effected may be considered half the requisite skill of portable pickup work.

The Don Lee Television portable 1½-ton truck in operation outside the Olympic Auditorium, Los Angeles. In this set-up visual monitoring equipment and transmitter are in the truck, the antenna is atop the building and the cameras, microphones, power connection and intercommunicating circuit are within the Auditorium. The truck was specially built to accommodate all equipment and supplies. Cameras may be placed on the roof in field operations.

Antennas at Don Lee Television

After a few years work, an organization usually comes to rely on a few types of antennas. In the Don Lee organization these have reduced to a "pickfork" type for transmitting and either the same or a "Vee" antenna for receiving. The merits of the former lies in portability, ease of erection, and signal-strength performance, while the merit of the latter lies in extreme sensitivity or gain. A pitchfork antenna consists of sixteen half-wave elements arranged in four groups spaced vertically one-half wavelength and horizontally one-fourth wavelength. Eight elements are driven and eight elements form parasitic reflectors spaced one-fourth wavelength away. A Vee antenna consists of two wires ten wavelengths long forming a "V" with a central angle of 30° and the open ends terminated in a small inductance, a 500 ohm resistor, and a vertical halfwave element "ground," while the closed end comprises a 300 ohm two-wire transmission line which conveys energy to the receiver.

As important as the antenna itself is the placement thereof in space. I am impelled to mention an experience of the National Broadcasting Company with the Empire State Building installation recently related to me. I do this to emphasize the importance of antenna placement and also to show that the problems and technique of this work are not unique to one organization, but are common to all operators in the field.

It seems that a pre-program test was in progress at the New York City station with not-too-encouraging results. The signal-to-noise ratio was not as high as desirable. Suddenly it doubled, and the receiver operator telephoned, "What did you do? It doubled the signal strength!" The portable transmitter operator at the program location came back with "Nothing." Investigation soon revealed that a routine window washer had just raised the window frame on which was attached the ultra-high frequency receiving antenna, raising it vertically about three feet! The effect of this increment in relation to the 1200 ft. antenna height requires little further comment on the importance of antenna placement.

In passing, the part that the last above-mentioned factor, "luck," played in this instance indicated that, although it cannot be counted upon in methodical preparation, it is often found in retrospect to be an important factor.

Placement of Antennas

To generalize the experience of the Don Lee organization with respect to antenna placement the following may be said. Increased elevation of antennae, even above purely wooden roofs, invariably increases the signal-to-noise ratio. Roughly, considering the placement of the transmitting antenna particularly, and in the range of from ten to fifty feet above a building structure, doubling the height of the antenna *above the structure* will double the signal to noise ratio. This holds whether the propagation path is line-of-sight or not, whether there is a clear sweep in front of the building toward the receiving station and whether the building is ten or a hundred feet high.

It is important to note that this effect predominates in spite of the reverse effect of increased feeder loss with increased length. The above statements include this counter-effect, which latter may double for each doubling of height if the transmitter is located at the base of the antenna mast. This performance is all the more surprising when it is recalled that feeder losses of 324 megacycles are large. We invariably use a two-inch-spaced number-twelve two wire feeder, Victron insulated.

Horizontal incremental displacements are equally important. These may be proposed according to the dicta of keeping the antenna furtherest removed from all metallic or non-metallic objects, but the composite effect of several such objects cannot be known until experimentally determined. Proper technique requires that all reasonable displacements be made during the propagation test period.

Operating the "Vee" Antenna

Vee antennae must be "steered" at the transmitted signal in order to achieve maximum response. Besides obviously moving the antenna in azimuth the vertical clearance above ground and the geometry of the Vee must be adjusted. The vertical angle of maximum receptivity decreases with vertical clearance. Particularly when the receiving location is a few thousand feet above the program location on the plain below, as at Mt. Lee, Hollywood, the Vee must be at least five wavelengths above ground. Alteration of the central angle of the Vee in increments of three degrees either side of the theoretical often results in reasonable signal increases, thereby compensating for some practical idiosyncrasy.

The last phase of allowing adequate time for preparation is concerned with the day of the telecast. Circumstances permitting, the portable crew is dispatched eight working hours before the scheduled conclusion of the telecast. A

crew of two engineers and an assistant are then able to drive the equipment truck to the location, establish necessary connections, place the cameras in position, install sound equipment, and make a complete test of facilities two to four hours before program time on a pickup of fixed format such as a baseball game, or boxing or wrestling match.

On more involved pickups, such as a soap-box derby, held in the hills and necessitating a portable gasoline-driven power truck, antenna erected in a field, cameras established on hillsides, telephone lines extended and conditions of self-sufficiency met as would become a military expedition, a crew of six men dispatched ten hours before conclusion of the program is required.

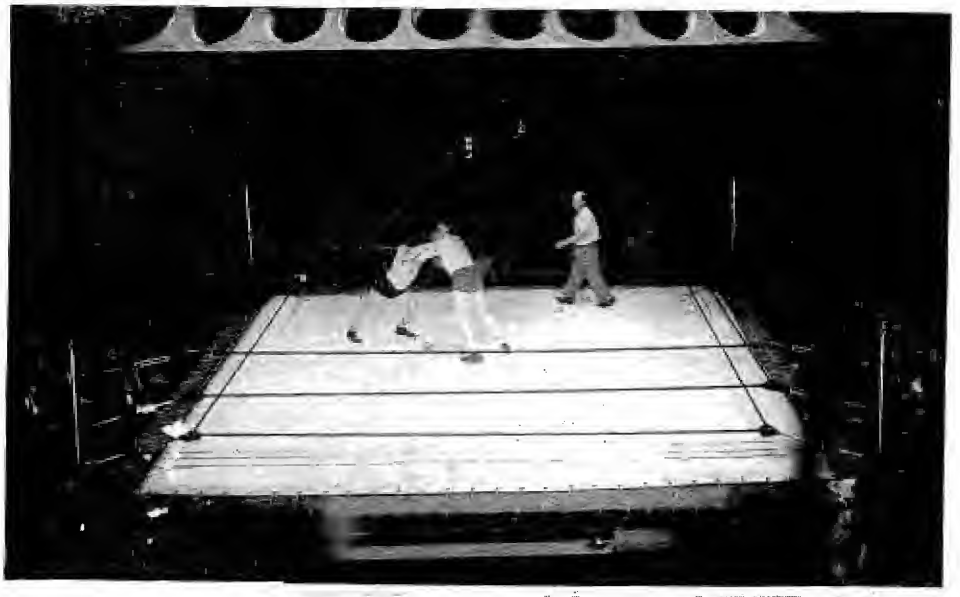
On Easter Sunrise pickups from the Hollywood Bowl it has been our practice to start our installation Saturday afternoon, make tests with the failing light of evening and then with the artificial light installed, work until nine o'clock Saturday night and then return at four a. m. Sunday morning. Electric heaters are kept on the equipment all through the night in order to prevent moisture infiltration requiring an inordinately long warm-up period.

On the other hand, we have occasionally televised two portable pickup programs in one day from two locations several miles apart with one set of equipment and one crew. With a trained crew of six men the equipment can be in operation one hour after arriving at a location.

Program Insurance

Passing now to the subjects of careful testing and a crew having the "feel" of the equipment, we consider these to be the best forms of program insurance. Capable portable pickup television engineers must carefully discern equipment performance under all sorts of surrounding conditions.

We have found that the manner in which equipment starts to function and ceases to function upon being switched on or off is a definite indication of any surge-provoked failure. We have found that if a condenser, resistor or other component fails it is usually during an on or off operation. The seriousness of a failure caused by shuting off the equipment at the end of a successful pre-program test will be appreciated. Thus, all engineers are instructed to carefully observe the "die-down" behavior of the equipment; such as the manner in which the images leave the monitor cathode ray tubes, the rapidity with which transmitter meters return to zero, a crackle, a minute spark, and, of course, any odor of burning insulation.



(Left) Inside the Olympic Auditorium. Special television illumination is seen at the top of the illustration, comprising ten 2 kw Moviefloods in suitable reflectors. One camera at this balcony location with a 24" focal length f.4.5 lens gives a reasonable closeup of the contestants. A 19" f.4.5 lens on a second camera at ringside level includes the whole ring. A sports announcer at the balcony location describes the action.

Scene of the second pickup of Easter Sunday, 1941 . . . telecasting the Easter Promenade from the Los Angeles Ambassador Hotel. Cameraman William Klein with the telephoto camera is seen at top of the portico at the left. The close-up camera is on the lawn, with Director Lubcke standing at the left. The monitoring equipment may be seen beneath the palm tree at the extreme left. The W6XDU transmitter was located on the opposite side of the portico, behind this equipment, with the antenna atop the portico.

This behavior is invariably uniform with properly functioning equipment. Anything unusual is a danger signal.

In addition, the functioning of the equipment during the pre-program test tells an experienced operator whether everything is normal, or whether the unusual operation of one or more control indicates a forthcoming failure. An engineer with a keen perception of these many operating indications has the "feel" of the equipment. Backed by a thorough knowledge of the theory of operation of the many circuits and a familiarity of the circuit diagrams covering the same, difficulties which would ordinarily require hours for diagnosis and cure may literally be removed in minutes.

Technical-Program Coordination

Technical-programing coordination is important in preventing avoidable disasters. This phase of operation has its inception in the technical and production heads witnessing a performance or having the sequence and locale of events described on the location by a qualified executive associated with the event. Decisions from artistic and technological viewpoints are reached, and departures therefrom involving general movement of the equipment just prior to program time are not allowed.

Adequate policing to prevent damage to the television equipment is recognized after the first telecast involving an appreciable contact with the uncontrolled public. At one Easter Sunrise service our portable transmitter W6XDU was taken off the air for a few minutes at the close of the program by a young man utilizing the power cable as a rope for climbing a steep hillside in the Hollywood Bowl. Our operator atop the hill saw the cable move, engaged in a tug-of-war with the unknown climber, but lost the contest; a large and sturdy plug being pulled from the companion socket in the equipment. The next year that cable was firmly tied to a stout stake driven in the ground, and a safety loop of cable was interposed between stake and socket.

In general, one or more policemen, Boy Scouts, or uniformed officials should be detailed to police the extended cables and equipment of a portable television installation.

No consideration of portable television operations would be complete without mention of the unpredictable combinations of circumstances and the attending consequences briefly described as "luck." It is futile to attempt to enumerate the countless happenings which might and do occur in such operations. The requirements of portability preclude duplicate channels of equipment, the vagaries of weather and natural illumination, factors beyond human control, and the newness of television instrumentalities does not insure a reliability accomplished in other technologies through years of design experience.

The first television pickup of the Pasadena Tournament of Roses Parade, New Year's Day, 1940. Cameraman Warren with the telephoto lens camera from which an image including an area twice that occupied by the horseman was received. The balcony shown is on the third story. The transmitting antenna was located on the roof from which this photograph was taken. Doubling the height thereof above the wood rooftop doubled the field strength at the main transmitter location 10 miles away in Los Angeles and not in line of sight.

Notwithstanding the almost supernatural aspect of this factor, it is submitted that a conscious alertness of staff tends to minimize the consequences of "bad" luck and to enhance the opportunities of "good" luck. Finally a confidence gained by a thorough familiarity with the equipment is a valuable adjunct.

The Don Lee Television transmissions may be received in the greater portion of the populated area of Southern California. Reception up to 60 miles from Mt. Lee is expected, but has not been proven by installation of television receivers in homes.

W6XAO Schedule

W6XAO transmits on a visual frequency of 51.25 megacycles and on an aural frequency of 55.75 megacycles. The waves are horizontally polarized and the conductors of the receiving antenna should be placed horizontally for best results. 525 line 30-60 frame interlaced Federal Communications Commission commercial standard television images are broadcast requiring a vertical scanning frequency of 60 cycles and a horizontal frequency of 15,750 cycles, both sawtooth waves.

Receiving Antenna

A satisfactory receiving antenna can be made by forming a half-wave dipole of two 50-inch long pieces of ⅜ inch diameter copper or aluminum tubing, with an insulator in the center. The two wires of a piece of EO-1 television twisted-pair feeder are attached to the respective pieces of the tubing at the insulator. The other ends of the feeder are attached to the antenna connections of the television receiver. It is desirable that the television antenna be erected as high as possible above surrounding objects, but positioned close to the television receiver so that the feeder may be less than 50 feet long. For reception of W6XAO, the antenna should be "pointed" toward the station atop Mt. Lee, Hollywood. This is accomplished by turning the antenna until the tubing is at the right angles to an imaginary line drawn between Mt. Lee and the receiving location, or by turning the antenna for strongest signal when W6XAO is on the air.

The Reflector

The received signal strength may be doubled by fitting a "reflector" to the previously described dipole. The reflector consists of one piece of ⅜" tubing 104" long placed parallel to the dipole tubing a distance of 53 inches therefrom on the side away from W6XAO. The reflector is *not* connected to dipole or feeder; it functions by itself. The diameter of the tubing for antenna or reflector is not critical and may vary from ¼" to ¾", depending upon the mechanical strength desired and the availability of material.

Work Sheet Data

Some of the data in the Work Sheet include "light" procedure, such as . . . the light must be sufficient to give a read-

(*Continued on page* 39)

MOTOR AND GENERATOR MAINTENANCE

by M. C. CISLER

Radio Transmitter Engineering Department, General Electric Company

IN the communication field it has always been the custom to inspect and service equipment periodically in order to maintain it in operating condition and thus guard against interruptions in service. Present-day conditions make it imperative that maintenance programs be intensified, not only because communications are vital on both the battle-front and home-front, but also because equipment cannot now be readily replaced.

It is the purpose of this article to discuss the maintenance of electric motors and generators employed in radio apparatus in an effort to keep breakdowns to a minimum and to extend the useful life of these machines. Wherever available the manufacturer's specific instruction sheet covering the machine should be consulted and followed.

Selection

A good maintenance program should be preceded by the proper selection and installation of the machines. The selection involves a study of operating requirements and the environment in which the machine is to operate. Operating requirements to be considered include such things as duty cycle, starting conditions, torque requirements, and speed regulation for a motor; excitation, voltage regulation, speed of voltage buildup, wave-form and voltage ripple for a generator. All of these have a bearing on just what type of motor or generator to choose. The operating environment may include high humidity, extremes of temperature, excessive dust, salt air, exposure to weather, vibration, tilt, or shock. Consideration of these determines the form and degree of enclosure, type and amount of insulation, type of bearings, method of lubrication, and method of mounting.

Figures 4, 6 and 8 show the general characteristics of a-c and d-c motors with their most common applications in radio apparatus. The more common uses of rotating generators are given in Figure 1. Remote-control devices as used in these tables cover the rotation or positioning of such parts as condensers, variometers, tuning coils, band-change switches, transfer switches, rotatable antennas, etc., which are controlled from a remote point and not manually driven. Control of these drives may be manual or automatic.

Installation

The proper installation of a motor or generator is an important item from the standpoint of long life and trouble-free operation. The machine should be located in such a way that it is accessible for inspection and repairs. Obviously, it is always advisable to install the machine in a place free from adverse conditions unless it is placed in a protecting enclosure. Ample ventilation must be provided so that heat losses from the machine will be carried away. If possible, the machine should be installed on a solid foundation which is free from vibration, or on resilient mountings to protect it from severe shock and vibration when present. Motors mounted within a radio transmitter or receiver should generally be provided with vibration-mounting to isolate their vibration from the radio apparatus. Care must be taken that motors are properly aligned and coupled to their loads.

Connections

All electrical connections to a motor and genertor should be tight, properly insulated, and supported so that vibration will not cause open or short circuits. Wires joined in a conduit box should be either twisted together and soldered, or bolted together. These joints should be wrapped first with rubber tape or varnished cambric, and then with friction tape. Wires issuing from a conduit box, especially rubber-covered extension cords, should be held in some manner so that there is no strain on the connections themselves. Usually a knot in the wire inside the conduit box, or the use of conduit-box fittings that grip the wire where it leaves the box,

Type of Machine	Purpose or Use	Installation
Gear-driven and wind-driven generators	For supplying low-voltage d-c, high-voltage d-c, or high-frequency a-c power for radio equipment	On aircraft
Motor-generators sets	For converting normal voltage a-c or d-c power to low-voltage d-c for filament supply or high-voltage d-c for plate and grid supply	On ships and in some land installations
Engine-driven generator sets	For supplying low and high-voltage d-c, 60-cycle a-c, or high-frequency a-c power for radio equipment	On large aircraft, in fixed stations not serviced by power lines, for mobile radio equipment, and for emergency use
Dynamotors	For converting low voltage d-c from storage batteries to high-voltage d-c for plate and bias supply	On aircraft, land vehicles, and smaller boats
Amplidyne generators	For generating controlled power for remotely controlled and automatically controlled drives.	Special
Selsyn or synchro-generators	For generating control voltages for indicators and for remotely or automatically controlled drives	Special

Figure 1
Generators in radio; their purposes and points of installation.

are the most convenient ways to obtain this strain relief.

All motors and generators used in radio equipment should have their frames grounded. A flexible copper strap or braid should be used for this purpose on machines which are resiliently mounted.

Electrical connections to all d-c machines used for radio equipment should be shielded and the shield well grounded at both ends to prevent the leads radiating an r-f disturbance caused by sparking at the brushes. D-c machines used to supply power to radio apparatus are usually provided with by-pass capacitors across their brushes and generally with a filter in their output leads.

Starting

A little extra care when starting a machine for the first time is a good investment. For example, trouble may be avoided by a look at the brushes of a d-c motor or generator or a single-phase repulsion motor to make sure that they are seating properly on the commutator, and with the proper pressure. Make certain that the proper amount of oil has been added to the reservoirs of oil-lubricated bearings. It is always good practice to turn the motor or generator over by hand before applying power to be sure it turns freely, and that no foreign material or objects have fallen into the machine during shipment or handling.

Inspection

After the machine has been properly selected, installed, and connected, the maintenance program really begins. To insure proper operation and maximum life, inspection and servicing should be systematic.

Frequency of inspection and degree of thoroughness vary, and will have to be determined by the maintenance engineer. They will be governed by (1) the importance of the machines in the apparatus, (2) percentage of time it operates, (3) nature of its service, (4) environment. An inspection schedule must, therefore, be elastic and adapted to the needs of each station or equipment. The following schedule, covering both a-c and d-c machines, is based on average conditions in so far as duty and dirt are concerned:

Figure 2
Greasing a pump motor with a hand-operated grease gun.

Every Week

1—Examine brushes and commutator.
2—Check oil level in bearings.
3—See that oil rings turn with shaft.
4—See that shaft is free from oil and grease from bearings.
5—Examine starter, switch, fuses and other controls.
6—Start motor and see that it is brought up to speed in normal time.

Every Six Months

1—Clean motor or generator thoroughly, blowing out dirt from windings and wipe commutator and brushes.
2—Inspect commutator clamping ring.
3—Check brushes and renew any that are more than half worn.
4—Examine brush holders and clean them if dirty. Make sure brushes ride freely in their holders.
5—Check brush pressure and brush position.
6—Clean dust and dirt from filter capacitors and see that their connections are tight.
7—Drain, wash out, and renew oil in sleeve bearings.
8—Check grease in ball or roller bearings.
9—Check operating speed or speeds.
10—See that end play of shaft is normal.
11—Inspect and tighten connections on motor, generator and control.

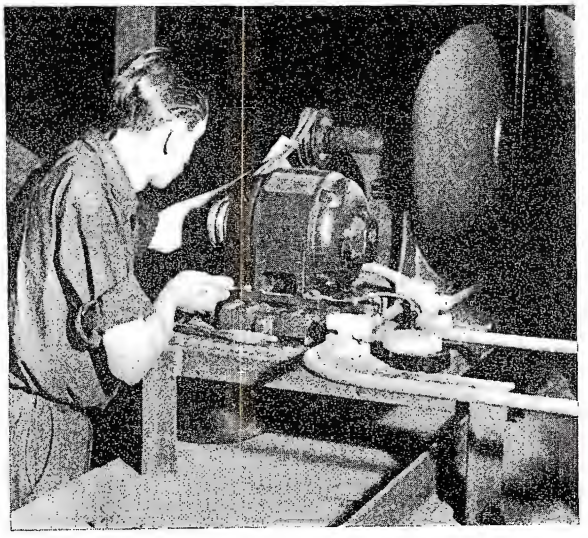


Figure 3
Installing the motor in such a way that it is accessible for inspection and repairs. Care should be taken to align the motor properly with the driven load.

Type	H.P. Ratings	Speed Regulation	Speed Control	Starting Torque	Pull-Out Torque	Application in Radio Apparatus
Split-phase	1/60 to 1/3	3% for large to 6% for small sizes	None	200% of full-load for high-speed to 75% for low-speed designs	200% of full-load	Fans, blowers, rotary compressors, centrifugal pumps, generators
Capacitor	1/30 to 5	3% for large to 6% for small sizes	None	200% to 400% of full-load depending upon speed and design	250% of full-load	Fans, blowers, rotary compressors, centrifugal pumps, reciprocating pumps and compressors, generators
Repulsion - Induction	⅛ to 5	3% for large to 6% for small sizes	None	200% to 400% of full-load depending upon speed and design	250% to 300% of full-load	Reciprocating pumps and compressors
Series - wound or Universal	1/100 to 1	Very high	From zero to maximum depending upon control and load	200% to 400% of full-load depending upon speed and design	Will not stall until loaded to its maximum torque which occurs at standstill	Fans, blowers, remote control devices
Shaded-pole	Up to 1/15	Quite high, 30% to 40%	None	150% to 300% of full-load depending upon size and design	Will not stall until loaded to its maximum torque which occurs at standstill	Fans, blowers, record players, remote-control devices
Synchronous — usually reluctance or hysteresis type	Up to 1/12	Constant speed	None	Depends upon design, ranges from 100% to 200% of full-load	Depends upon design and rating, usually ranges from 100% to 150% of full-load	Record players and special applications

Figure 4
Characteristics and applications of single-phase a-c motors.

12—Check current input to motors and field excitation to generators and compare with normal.
13—Run machine and examine critically for smooth running, absence of vibration and unusual noise, worn gears, couplings, chains or belts.
14—Check mounting bolts, end-shield bolts, coupling, pulley or gear set-screws and keys.
15—See that all motor covers, belt, gear and coupling guards are in good order, in place, and securely fastened.
16—Make certain that resilient mountings are clean and in good condition.

Once a Year

1—Clean out and renew grease in ball or roller bearing housings.
2—Test insulation by megger.
3—Check air gap.
4—Clean out magnetic dirt that may be hanging on poles.
5—Check clearance between shaft and journal boxes of sleeve-bearing machines to prevent operation with worn bearings.
6—Clean out undercut slots in commutator.
7—Examine connections of commutator and armature coils.
8—Inspect armature bands.
9—Clean and inspect centrifugal starting switch on single-phase motors.

Records

It is recommended that the maintenance man keep a record card for each motor and generator under his care. Every inspection and all repair work with its date and cost should be entered on the card. In this way excessive amounts of attention or expense will show up and the causes can be determined and corrected. Inspection records will also serve as a guide to tell when machines should be replaced because of the high cost of keeping them in operating condition. Mis-applications, insufficient protection, and the like will also be disclosed.

Lubrication

One of the major features of a maintenance program, from the standpoint of effect upon the general performance of a motor or generator, is proper lubrication.

The bearings of modern machines, whether sleeve, ball or roller, require only very infrequent attention. Too often the oiling and greasing of new motors and generators is entrusted to careless attendants who are accustomed to lubricating older designs with bearings housings less tight than on modern machines. As a result, oil or grease is copiously and frequently applied to the outside as well as the inside of bearing housings. Some of the excess lubricant is carried into the machine and lodges on the windings to deteriorate insulation, catch dust, and thereby hasten ultimate failure.

If the correct amount of the proper lubricant is applied before starting, there should be no need to refill the housings for several months, even in dusty places.

Greasing Ball-Bearing Machines

Ball-bearing machines operating in normal ambient temperatures should be lubricated with a high-grade grease, having the following general characteristics: (1) Consistency a little stiffer than that of vaseline, maintained over the operating-temperature range. (2) Melting point preferably over 150° C. (3) Freedom from separation of oil and soap under operating and storage conditions. (4) Freedom from abrasive matter, acid, and alkali. Machines operating in extremely high or low am-

bient temperatures should be lubricated with the grease recommended by the manufacturer for these temperatures.

In greasing, care must be taken not to add too much grease in a bearing housing, as this will cause the bearing to run hot with resulting expansion and leakage of the grease.

The following procedure is recommended for greasing ball-bearing machines equipped with a pressure-relief greasing system: (1) Thoroughly clean the pressure-gun fitting, bearing housing and relief plug so that no dirt enters the bearing with the grease. (2) Always remove the relief plug from bottom of bearing housing before using the grease gun. This prevents putting excessive pressure inside the bearing housing. Excessive pressure may rupture the bearing sales. (3) With a clean screwdriver or similar tool free the relief hole of hardened grease so that any excess grease can run freely from the bearing. (4) With the machine running, add grease with a hand-operated pressure gun until it begins to flow from the relief hole. This tends to purge the housing of old grease. (5) If it is dangerous to lubricate the machine while running, follow the above procedure with the machine at a standstill. (6) Run machine long enough after adding grease to permit rotating parts of bearing to expel all excess grease from the housing. This is important since it prevents over-greasing the bearing. (7) Stop machine and replace relief plug tightly.

Greasing Ball-Bearing Machine Not Equipped with a Pressure-Relief System

Machines not equipped with a pressure-gun fitting and a relief plug on their bearing housings cannot be greased by the procedure outlined above. Under most operating conditions, the grease with which the bearings of these machines were packed at the factory is sufficient to last approximately one year. When the first year of service has elapsed, and once a year thereafter (or oftener if conditions warrant), the old grease should be removed and the bearings supplied with new grease. The following procedure is recommended: (1) Disassemble the bearing housings and clean the inside of the housing, the housing plates or caps, and the bearings with carbon tetrachloride (carbona), gasoline or naphtha. A small, soft-bristle brush will be found helpful in cleaning.

Caution

On most motors and generators, the inner race of the ball-bearing is pressed tightly on the shaft and the bearing cannot be readily removed from the shaft without injuring it. Never hammer or strike a ball-bearing. Do not expert pressure against the outer race or ball retainer to remove or replace a bearing whose inner race has a press fit on the shaft. If bearing must be removed, use a bearing puller which grips the end of the inner race. In replacing the bearing, use a sleeve or pipe of correct diameter which contacts only the end of the inner race and press the bearing on the shaft until the inner race rests against the shoulder on the shaft. On most machines it is unnecessary, and inadvisable, to remove the bearings from the shaft in order to clean and grease them.

(2) When thoroughly cleansed of old grease, reassemble all parts except the outer caps or plates. Extreme caution should be exercised in preventing dust and dirt from entering a ball-bearing and its housing. Do not permit a ball-bearing to be exposed for any length of time, even in a clean room, without covering with a clean paper or cloth, to prevent dust settling on it. If bearing is not to be greased immediaely after cleaning, it should be slushed with clean oil to prevent its rusting, since clean steel surfaces rust rapidly unless protected.

(3) Apply new grease, either by hand or from a tube, over and between the balls. The correct amount of grease to be added varies with the type and size of machine. Consult the instruction sheet which accompanied the machine for this information. In general, the proper amount of grease fills the bearing housing about one-third, and certainly not more than one-half, full. Using more than the amount specified will result in an abnormal bearing temperature rise.

(4) When reassembling the machine, any V-grooves found in the housing lip should be refilled with grease—preferably a fibrous, high temperature-sealing grease—which will act as a protective seal against the entrance of dirt or foreign particles.

The technique for greasing machines equipped with roller bearings is similar to that used for ball-bearings. Specific instructions for the individual design should be followed, however, because more frequent greasing or slight changes in technique may sometimes be necessary.

Oiling Sleeve Bearings

The sleeve-bearing housings on larger motors and generators are usually provided with an oil reservoir and oil rings. The oil level in these housings should be checked periodically with the machine stopped. If the machine is equipped with an oil-filler gauge, the gauge should be about three-quarters full at all times.

This type of sleeve-bearing is provided with a liberal settling chamber into which dust, dirt and oil sludge collect. If the oil is dirty, drain it off by removing the drain plug usually located in the bottom or side of the bearing housing. Flush the bearing with clean oil until the outcoming oil is clean. Whenever the machine is disassembled for general cleaning, the bearing housing should be washed out with solvent. Before reassembling, dry the bearing lining and apply a film of oil on the shaft.

The sleeve-bearings of most fractional horsepower motors have no means for checking oil level since the oil is held in waste packing. For normal service, add from 20 to 50 drops of oil to each bearing (depending upon its size) at the end of the first year and repeat at the end of each subsequent one-thousand hours of operation or an elapsed time of one year, depending upon which comes first. Very small motors may require more frequent lubri-

(Continued on page 22)

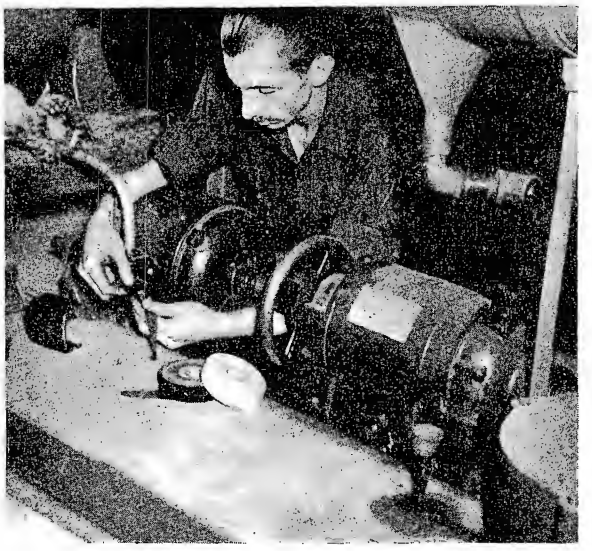


Figure 5

Connections to a motor should be made tightly enough so that the vibration of the equipment will not loosen them. Wires joined in a conduit box should be either twisted together and soldered, or bolted together. These joints should be wrapped first with rubber tape, and then with friction tape.

(*Continued from page 7*)

age may be represented by the equation:

$$e = E \sin\left(2\pi f_k t + \frac{f_d}{f_m} \sin 2\pi f_m t\right) \quad \ldots\ldots\ldots\ldots (11)$$

in which f_d, the deviation, is the change in frequency from the unmodulated carrier value and f_m is the modulation frequency of the audio-frequency signal. Comparison of Eqs. (10) and (11) shows that they are similar in form if Eq. (9) is written in the form

$$e = E \sin\left(2\pi f_k t + \frac{F_d'}{f_{k1}} \sin 2\pi f_{k1} t\right) \quad \ldots\ldots\ldots\ldots (12)$$

where $f_d' = -f_{k1}\phi_1$.

The action of a properly designed discriminator is such that the output voltage is proportional to the deviation of the impressed frequency-modulated voltage. Therefore the ratio of the undesired beat-frequency output to the desired audio-frequency output of the discriminator is

$$N/S = f_d'/f_d = f_{k1}\phi_1/f_d \quad \ldots\ldots\ldots (13)$$

Analysis of Eq. (6) shows that when E_1/E_k is less than 0.5, ϕ_1 is approximately equal to E_1/E_k radians. This may also be seen from an examination of Figure 3. Therefore

$$N/S = \frac{f_{k1}}{f_d} \times \frac{E_1}{E_k} \quad \ldots\ldots\ldots\ldots (14)$$

Comparison of Eqs. (7) and (14) shows that the interference-to-signal ratio is lower in the f-m system by the factor f_{k1}/f_dM, which equals f_{k1}/f_d when the amplitude modulation factor is unity. Equation (14) shows that the strength of the heterodyne whistle caused by the interfering carrier is proportional to the difference frequency and approaches zero as the carrier frequencies approach equality. When pre-emphasis of high frequencies is not used, the interference is greatest in an f-m receiver when f_{k1} has its greatest value, which is the highest frequency, f_h, passed by the a-f amplifier that follows the discriminator. For a deviation of 75,000 cycles and a 15,000-cycle a-f band width, Eq. (14) shows the maximum interference-to-signal ratio to be

$$\text{Max. } N/S = \frac{15{,}000}{75{,}000} \frac{E_1}{E_k} = 0.2\ E_1/E_k \quad \ldots\ldots\ldots (15)$$

Hence, under the worst condition, i.e., when the interfering carrier frequency differs by 15,000 cycles from the desired carrier frequency, the suppression of the undesired carrier is 5 times as great as in the a-m system. Greater improvement results if the a-f pass band is narrower.

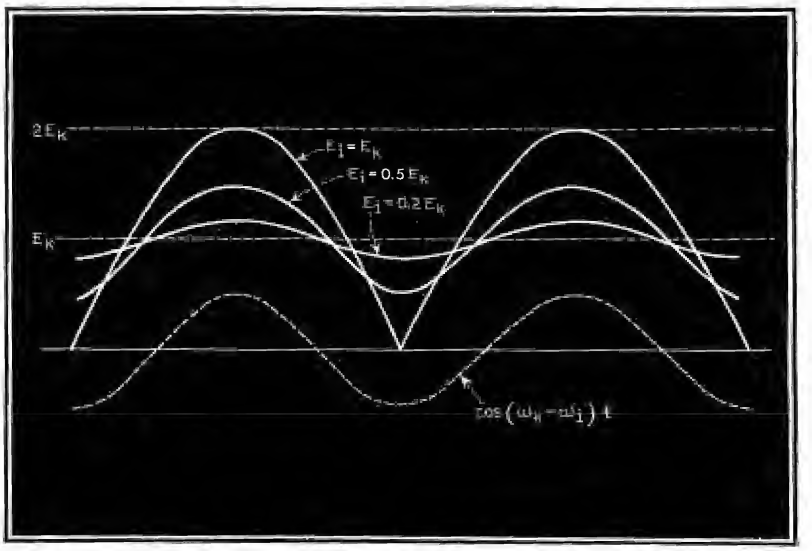


Figure 2

Considerable improvement results from the use of pre-emphesis of high frequencies. The amplitude of the modulation voltage impressed upon the modulator of the transmitter is made to increase linearly with frequency above 1,500 cycles, and the response of the discriminator is made to vary inversely with frequency above 1,500 cycles so as to give a signal output amplitude that is independent of frequency. The output of the discriminator is then proportional f_d' and inversely proportional to f_{k1} above 1,500 cycles. The amplitude of the heterodyne whistle caused by an interfering carrier increases linearly with f_{k1} below 1,500 cycles and remains constant at the 1,500 cycle value above 1,500 cycles. The value of N/S then does not exceed the value obtained when f_{k1} is 1,500 cycles, i.e., 0.02 E_1/E_k. Hence the use of pre-emphasis increases the suppression of an undesired carrier by a factor of 10, making the suppression 50 times as great as in an a-m system.

MODULATED CARRIERS

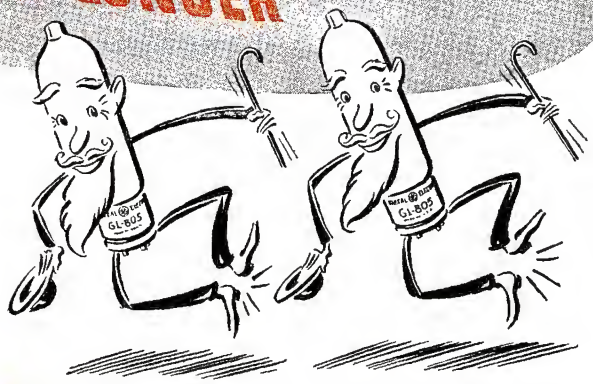
Of more importance than the case just discussed is that in which one or both carriers are modulated. In an f-m system, the instantaneous difference in frequency between the two signals will then vary. As already shown, the beat-frequency output has its maximum value in a system without pre-emphasis only when the difference frequency is equal to the maximum audio frequency. When pre-emphasis is used, the beat-frequency amplitude is constant for values of beat frequency above 1,500 cycles. In either case, the maximum value is obtained during only a portion of the modulation-frequency cycle. Furthermore, if both waves are modulated, the difference frequency will be above the a-f amplifier range during a part of the time, even when the unmodulated carrier frequencies are equal. Hence, the average strength of the interference output will be less than when the carriers are unmodulated and the N/S ratio will be less than 0.2 E_1/E_k without pre-emphasis and less than 0.02 E_1/E_k when pre-emphasis is used.

STATIC INTERFERENCE

Although static is not ordinarily a periodic disturbance, by aplication of Fourier theory it may be considered to consist of a continuous spectrum of frequencies. Any frequency component in this spectrum may be represented by the second term in Eq. (1). Equation (2) then represents the instantaneous voltage impressed upon the receiver as the result of the desired carrier and the given component of the frequency spectrum. In an a-m receiver, the resulting output is equal to $sM'E_k$, where s is the receiver sensitivity and M' is the modulation factor corresponding to modulation of the desired carrier by the given static component. From Fig. 2 it can be seen that $M' = E_1/E_k$. Therefore the receiver output is sE_1. Since the output frequency f_{k1} is the difference between the frequency of the given component and that of the carrier, only

(*Continued on page 19*)

10 Suggestions to make your THORIATED-tungsten-filament tubes LIVE LONGER



HERE'S HOW you can easily remove many of the causes of premature tube failure

1 Don't overload the tubes. Use adequate protective devices such as a fuse or relay. Heavy overloads are apt to evaporate the thorium surface from the filament, and permanently damage the tube.

2 Normal operating temperature for thoriated-tungsten-filament tubes is obtained by operating them at the *rated* filament voltage. Care should be taken to operate them *at this voltage* (except for standbys and when reactivating). Occasionally, under or over voltage will give longer life, but such operation should only be carried out after first consulting the tube manufacturer.

3 Tubes that have been momentarily overloaded, or run at subnormal filament temperature, can quite frequently be reactivated by following this simple procedure: Operate the filament at the rated voltage for ten minutes or more with no voltage on the plate or grid. This process can be accelerated by increasing the filament voltage to 20 per cent above the rated value for a few minutes.

4 Increase the filament voltage progressively (only a small percentage at a time) when a tube no longer responds to reactivation. New filament transformers may be necessary for such operation.

5 For tubes of *250-watt plate dissipation or higher,* when the load on the tube is intermittent, keep the filament at 80 per cent of normal voltage during standby periods of *less than two hours.* This helps keep the cathode surface replenished, and makes it more quickly available when raised to normal filament voltage. If the standby period is *more than two hours,* the filament current should be shut off.

6 For tubes of less than 250-watt plate dissipation, filament voltage should be removed for standbys of more than 15 minutes.

7 For all types of thoriated-tungsten-filament tubes if the off period is less than five minutes, operate the filament at full voltage continuously, as excessive heating and cooling cycles tend to distort this type of filament.

8 Keep tubes well ventilated—with fans or blowers, if necessary.

9 Run at lowest possible anode current and voltage.

10 Minimize plate dissipation by careful tuning of the transmitter.

The Navy "E", for Excellence, has been awarded to 92,780 General Electric employees in five plants manufacturing naval equipment

These Suggestions Apply to Such Tubes As These G-E Thoriated-tungsten-filament types:

GL-146	GL-276A	GL-812	GL-849
GL-152	GL-800	GL-813	GL-851
GL-159	GL-801	GL-814	GL-860
GL-169	GL-803	GL-833A	GL-861
GL-203A	GL-805	GL-834	GL-865
GL-204A	GL-806	GL-835	GL-1623
GL-211	GL-809	GL-838	GL-1628
GL-217C	GL-810	GL-845	
GL-242C	GL-811		

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Manufacturers of Aircraft, Marine and Mobile Radio Communication Equipment

NEW YORK, N. Y. WASHINGTON, D. C.

INTERFERENCE SUPPRESSION IN A-M AND F-M

(*Continued from page* 16)

those static components whose difference in frequency from the carrier lies within the audio-frequency pass band of the receiver contribute to the noise. The total output caused by static is the sum of the outputs resulting from these components.

$$N = \int_{f_k - f_h}^{f_k + f_h} sE_i df \quad \ldots\ldots (16)$$

in which f_h is the uper audio-frequency limit of the receiver and E_i is the amplitude of a static component of frequency f. If E_i and s are assumed to be independent of f, Eq. (16) reduces to

$$N = 2sE_i f_h \quad \ldots\ldots (17)$$

in which the value of E_i depends upon the form and amplitude of the noise impulse. The signal output of the receiver is

$$S = sME_k \quad \ldots\ldots (18)$$

Hence the noise-to-signal ratio is:

$$N/S = 2E_i f_h / ME_k \quad \ldots\ldots (19)$$

In an f-m receiver, the output resulting from a given noise component is

$$N_i = E_k s f_d' = E_k s f_{ki} \phi_i \cong E_k s f_{ki} E_i/E_k = s(f - f_k) E_i \quad \ldots\ldots (20)$$

The total noise output from a receiver without pre-emphasis compensation is

$$N \cong \int_{f_k}^{f_k + f_h} E_i s(f - f_k) df + \int_{f_k - f_h}^{f_k} E_i s(f_k - f) df = E_i s f_h^2 \quad .(21)$$

The desired audio-frequency signal output is

$$S = E_k s f_d \quad \ldots\ldots (22)$$

Therefore

$$N/S = \frac{E_i}{E_k} \times \frac{f_h^2}{f_d} \quad \ldots\ldots (23)$$

Comparison of Eqs. (19) and (23) shows that for the same audio-frequency range the noise-to-signal ratio is lower in the f-m receiver in the ratio $Mf_h/2f_d$ when high-frequency pre-emphasis is not used. For 100 per cent amplitude modulation, a 5000-cycle audio-frequency band width, and 75,000-cycle deviation, this improvement ratio is 1/30. For a 5000-cycle a-f band width in the a-m receiver and a 15,000 cycle a-f band width in the f-m receiver, the improvement ratio is 1/10.

When pre-emphasis is used, the response of the discriminator varies inversely with frequency for modulation frequencies above 1500 cycles, and N_i has the constant value $1500sE_i$ above 1500 cycles. If it is assumed that this value also holds below 1500 cycles, the total noise output is given by the relation:

$$N < 1500s \int_{f_k - f_h}^{f_k + f_h} df = 3000sf_h \quad \ldots\ldots (24)$$

and

$$N/S < 3000 \frac{E_i}{E_k} \times \frac{f_h}{f_d} \quad \ldots\ldots (25)$$

N/S is then smaller in the f-m system than in the a-m system in the ratio $1500M/f_d$, which is equal to 1/50 when M equals unity and f_d equals 75,000 cycles. This clearly predicts the large decrease in static interference observed in f-m receivers over a-m receivers. A similar analysis may be made for other types of noise interference.

A similar analysis may also be made to show that noise output is smaller in the f-m system than in the a-m system when the receiver is not tuned to a carrier. This is done by letting the two voltages in Eq. (1) be those corresponding to any two components in the noise spectrum, one of which is in effect considered to be modulated by the other.

Much of the analysis that has been made in this paper involves the tacit assumption that the superposition theorem may be applied. The same assumption is made in the usual mathematical analyses of modulation. Analyses based upon modulation at a single frequency are assumed to be valid when the carrier is modulated simultaneously at two or more frequencies. Perhaps the best proof of the validity of the superposition theorem in such analyses is the fact that very low values of amplitude distortion may be attained in practice. In analyses of frequency modulation systems a second justification for the application of the superposition theorem lies in the linearity, with respect to frequency, of the various elements of properly designed systems.

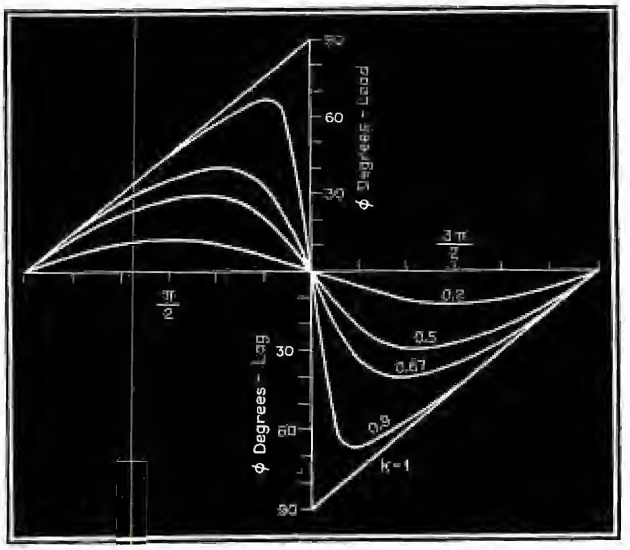

Figure 3

APPENDIX

$$e = E_k \sin \omega_k t + E_i \sin \omega_i t$$
$$= E_k \sin \omega_k t + E_i \sin [\omega_k t - (\omega_k - \omega_i)t]$$

Let $\omega_k - \omega_i = \omega_{ki}$

Then $e = E_k \sin \omega_k t + E_i \sin \omega_k t \cos \omega_{ki} t - E_i \cos \omega_k t \sin \omega_{ki} t$

$$= [E_k + E_i \cos \omega_{ki} t] \sin \omega_k t - E_i \sin \omega_{ki} t \cos \omega_k t$$

Let $A = E_k + E_i \cos \omega_{ki} t$

and $B = E_i \sin \omega_{ki} t$

Then $e = A \sin \omega_k t - B \cos \omega_k t$

$$= \sqrt{A^2 + B^2} \left[\frac{A}{\sqrt{A^2 + B^2}} \sin \omega_k t - \frac{B}{\sqrt{A^2 + B^2}} \cos \omega_k t \right]$$

Let $\frac{A}{\sqrt{A^2 + B^2}} = \cos \phi$

and $\frac{B}{\sqrt{A^2 + B^2}} = \sin \phi$

(*Continued on page* 20)

RECORDING STANDARDS

ON April 29, 1942, an executive committee of the NAB recording and reproducing standards committee met to prepare a report setting forth and recommending such standards as were deemed ready for adoption. Standards were recommended for adoption as a result of this meeting.

The standards recommended for adoption do not cover all of the subjects assigned to the sub-committees. Some subjects were found to require considerable additional development effort which it was felt could not be undertaken because of the war. Standards are still required for groove contour, distortion, low frequency noise, standard tone record, and several others perhaps of lesser importance.

In making this report, the committee reported that they were aware that the work of standardization of electrical transcription for radio broadcasting is still incomplete. There is, however, the essential elements of a complete and practical set of standards which will help. The committee members have found it increasingly difficult in recent months to devote time to this work due to demands on their time by the war effort. For this reason it is felt by the committee that the efforts of the NAB Recording and Reproducing Standards Committee should be discontinued for the duration of the war or until such time as conditions permit a resumption of the development activity necessary to this work.

"The standards recommended for adoption were:

(1). *Recorded Level*: The program level recorded (and hence capable of reproduction under normal conditions) when measured by a standard volume indicator shall be the same as the level required to record a 1,000 cycle tone at a velocity of 5 centimeters per second.

It is well established that a 10 db margin is required between the sine wave load handling capacity of a system and the level of program material measured by a volume indicator. This standard would then contemplate program peaks running as high as a velocity of 15 centimeters per second. This is believed to be approximately the maximum velocity which can be traced without excessive distortion at groove speeds encountered at the inner radius of a 33 1/3 R.P.M. disc. This standard, of course, applies to both lateral and vertical recording.

(2). *Signal to Noise Ratio*: The noise level measured when reproducing a record on a flat velocity basis over a frequency range between 500 and 8,000 cycles per second shall be at least 36 db below the level obtained under the same conditions of reproduction using a tone record of 1,000 cycles having a velocity of 5 centimeters per second.

This measurement is intended to give a measure of noise in terms of a fixed reference. In this way it becomes a true figure of merit for comparisons of variations in surface noise of discs. It does not, however, take into account the program level which may happen to be recorded on a particular disc nor the dynamic range of the program material. Pre-emphasis will improve the signal to noise ratio by approximately 8 db, thus resulting in an effective signal to noise ratio under minimum conditions of 44 db.

(3). *Concentricity of Center Hole*: The record center hole shall be concentric with the recording groove spiral within 0.003 inches. This standard is intended to establish the accuracy which is required in the process of relocating the center of the stamper from which pressings are made.

(4). *Turntable Diameter*: The minimum diameter of the reproducing turntable shall be 15⅝ inches. This figure has been chosen to provide on one hand, a complete support of the record for its entire recorded area, and, on the other hand, to provide an overhanging edge so as to make it possible for the operator to slip the record.

(5). *Minimum Turntable Torque*: The minimum torque at the turntable shall be 100 inch ounces. The committee recommends a minimum value of 100 inch ounces which will permit slipping the record as a method of starting. It was felt that this method of starting provides the most severe conditions to be considered and is at the same time the most likely to be used.

(6). *Reproducing Turntable Speeds*: The average speed of the reproducing turntable shall be either 33 1/3 or 78.26 R.P.M. ± 5%.

(7). *Reproducing Turntable "Wow" Factor*: The maximum instantaneous deviation from the mean speed of the reproducing turntable shall not exceed ± 0.3% of the mean speed.

(8). *Output Level of the Pickup Equalizer Combination*: The minimum level of the pickup equalizer combination when reproducing 1,000 cycles recorded at a velocity of 5 centimeters per second shall be —65 vu.

(9). *Frequency Response of Pickup and Equalizer*: The frequency response of the pickup and equalizer combination when used to reproduce a Vinylite pressing (or record of material giving equivalent translation loss) shall be the inverse of the N.A.B. standard recording characteristic with ± 2 db. For reproduction at 78 r.p.m. of home phonograph records it is recommended that the inverse of the average recording characteristic be used with a network to reduce the surface noise above 4,000 cycles.

(10). *Tracking Error of Pickup*: The maximum tracking error shall be 6° at 4″ diameter, 10° at 15½″ diameter.

(11). *Vertical Force of Pickup*: The maximum vertical force required by the reproducer shall be 1½ ounces (42 grams).

(12). *Translation Loss*: The pickup shall be so designed that the translation loss as determined by the difference in level of reproduction of 8,000 cycle bands on the inside and outside diameters of a standard 16″ Vinylite tone record be not in excess of 6 db.

(13). *Turntable Cabinet Height*: It is recomended practice that the height of a reproducing turntable cabinet be 30½ inches.

In addition to the above standards the committee recommended the adoption of a glossary of recording terminology contained. This glossary, while not complete, includes most of the terms peculiar to the disc recording art.

A-M and F-M

(*Continued from page* 19)

Then $\tan \phi = \frac{B}{A} = \frac{E_1 \sin \omega_{k1} t}{E_k + E_1 \cos \omega_{k1} t}$

and

$$e = \sqrt{A^2 + B^2}\,[\cos \phi \sin \omega_k t - \sin \phi \cos \omega_k t]$$
$$= \sqrt{A^2 + B^2} \sin (\omega_k t - \phi)$$
$$= \sqrt{E_k^2 + 2 E_k E_1 \cos \omega_{k1} t + E_1^2} \sin (\omega_k t - \phi)$$

Let $E_1/E_k = h$

Then $e = E_k \sqrt{1 + 2h \cos \omega_{k1} t + h^2} \sin (\omega_k t - \phi)$

where $\phi = \tan^{-1} \frac{h \sin \omega_{k1} t}{1 + h \cos \omega_{k1} t}$

[1]Roder, H., Proc. IRE, Vol. 19, p. 2145 (1931)
Van der Pol, B., Proc. IRE, Vol. 18, p. 1194 (1930)

MOTOR AND GENERATOR MAINTENANCE

(*Continued from page* 15)

cation—about every three months—but only 5 to 10 drops of oil should be added each time.

The oil used should be a high-grade motor oil of viscosity ranging from SAE-10 for very small machines to SAE-30 or SAE-40 for large ones.

Cleaning Ball Bearings

The pressure-relief method of greasing ball-bearings, described above, tends to purge bearing housing of used grease. Complete cleaning of these bearings, therefore, is required at infrequent intervals only. For a thorough and convenient flushing of the bearings without disassembly, the following method is recommended.

(1) Wipe the housing, pressure-gun, and relief fittings and remove both fittings. Every care should be taken to keep dirt out of the bearings. A bit of abrasive once in a ball-bearing cannot be removed even with the most thorough cleaning and it usually will cause permanent injury to the bearing.

(2) With a clean screwdriver or other convenient tool, free the pressure-fitting hole in top of bearing housing and relief-plug hole in bottom of housing of old and hardened grease. Fill a syringe with grease solvent such as carbon tetrachloride or gasoline, and inject some of it into the pressure-fitting hole while the machine is running. The solvent will thin the grease and drain out through the relief hole. Continue to add solvent until it drains out quite clear.

(3) Replace the relief plug and inject solvent until it can be seen splashing in the filling hole. Allow the solvent to churn for a few minutes, then remove the relief plug and drain off the solvent. Repeat this churning operation until the solvent runs clean.

(4) To remove the solvent, replace the relief plug and inject a small amount of light lubricating oil. Allow this to churn for one or two minutes and drain off. Complete the job by greasing the bearing, using the method previously described.

(5) For totally enclosed, fan-cooled motors and generators, the fan cover and fan will first have to be removed in order to make the drain plug on the fan-end bearing accessible.

Brush Inspection

For satisfactory operation, brushes on d-c motors and generators should have free movement in their holders and should make proper contact with the commutator. Brush holders should be set so that the face of the holder is approximately ⅛ inch up from the commutator. Spacings greater than this will cause brushes to wedge, resulting in chattering and excessive sparking.

Improper brush pressure may lead to abnormal commutator wear or excessive sparking and heating. Uniform brush pressure is necessary to assure equal current distribution. Larger machines have means for adjusting the brush-spring pressure. The proper value is 2 to 2½ lbs. per sq. in. of brush contact area with the commutator. In case excessive heating has annealed the springs, replace them with new ones and correct the cause of heating.

Check brushes to make certain they will not wear down too far before the next inspection. It is false economy to use brushes down to the absolute minimum length before replacement. Do not take a chance on wearing down brushes until the pigtail-connecting rivet touches the commutator, as this will cause severe damage to the commutator. In general, brushes should be replaced when they have worn down to one-half their original length.

Keep an extra set of brushes available so that replacement can be made when needed. It is important to use the grade, type and size of brush recommended by the manufacturer for that machine.

During inspection, check that the end of the brush has a polished surface, indicating good contact with the commutator. The polish should cover at least three-quarters of the contact area of the brush. When replacing brushes after inspection, cleaning or dissembly, make certain that each brush is placed in its original brush holder in exactly the same position as it was before removal. A practice found helpful to this end is to mark the top side of each brush with "L" or "R" (denoting left or right-hand side) and to place a corresponding mark on the top side of its brush holder, or on the yoke or frame adjacent to the brush holder.

New brushes should be carefully fitted to the commutator and, if possible, the machine should be run without load for a half-hour or longer before placing it in regular operation. To do this, place the new brushes in their holders and insert a strip of fine sandpaper, abrasive side up, between the commutator and brushes. Rotate the commutator back and forth, allowing the brushes to bear on the sandpaper only when the commutator is moving in the proper direction of rotation. The brushes should be lifted so that they will not touch the sand paper on the back

(*Continued on page* 30)

Type	Starting Torque	Maximum Momentary Running Torque	Speed Regulation	Speed Control	Applications in Radio Apparatus
Shunt - wound, constant-speed	Limited by starting resistor to 125% to 200% of full-load torque	125% to 200% of full-load, limited by commutation	8% to 12%	Basic speed to 200% basic speed by field control	Fans, blowers, rotary compressors, centrifugal pumps, reciprocating pumps and compressors, generators, remote-control devices
Shunt - wound, adjustable-speed			10% to 20%	Basic speed to 600% basic speed by field control	
Compound-wound, constant-speed	Limited by starting resistor to 130% to 260% of full-load torque	130% to 260% of full-load, limited by commutation	25% for standard compounding	Basic speed to 125% basic speed by field control	Drives requiring high starting torque and fairly constant speed. Usually not employed in radio apparatus
Series - wound, varying-speed	300% to 400% full-load torque	300% to 400% of full-load, limited by commutation	Very high, dangerous no-load speed	From 0 to maximum depending upon contral and load	Fans, blowers, remote control devices

Figure 6
Characteristics and applications of d-c motors

IT STAYS PUT

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NEWS BRIEFS OF THE MONTH...

NAVY ASKS FOR ENGINEERS

An activity of the United States Navy is in need of civil junior, assistant and associate radio engineers; assistant and associate physicists and physicists for laboratory research and development work in conjunction with the war effort program. Salaries range from $2,000 to $3,800 per annum. For further information and application for employment form write the Director, U. S. Navy Radio and Sound Laboratory, San Diego, California.

* * *

RESISTOR CATALOG

A 12-page catalog bulletin 98 has just been published by Lectrohm, Inc., Cicero, Illinois.

This new piece of literature presents information on a wide range of fixed, adjustable, "rib-on-edge" and ferrule terminal resistors, power line and r-f chokes, brackets, bushings, terminals and washers.

Also illustrated and described are small solder pots, of Lectrohm design and manufacture, constructed for continuous operation in radio, motor and similar electrical equipment plants. These pots have capacities of 1¾ and 2 pounds each.

The bulletin may be obtained by writing direct to the manufacturer.

* * *

ELECTRIC HEAT PREVENTS ICE FORMATION

Electric heat has been used successfully by Station W51R, Rochester, N. Y., to prevent ice from forming on its transmitting antenna located atop one of Rochester's down-town buildings.

The antenna consists of two sets of hollow crossed arms mounted one above the other on a mast in a horizontal plane. To prevent the formation of ice, a four-foot G. E. Calrod heater has been built into each of the cross arms. The current to the heaters is turned on automatically when the temperature is within the sleet-forming range of 28° to 32° F.

This is accomplished by two thermostats mounted on the mast of the antenna. Both thermostats must be closed in order for the heaters to work. It is impossible for the heaters to function outside the temperature range of 28-32 F. since one thermostat closes when the temperature falls below 32 degrees and the other opens when it falls below 28 degrees.

* * *

PITTMAN ADVANCED BY G. E.

C. F. Pittman, manager of the motor division of the G. E. industrial department, has been named assistant to the manager of the industrial department. W. H. Henry, who was manager of sales in the motor division, succeeds Mr. Pittman as manager of the division.

* * *

OSCILLOGRAPH ACCESSORY CATALOG

Form 32B-42, describing oscillograph accessory apparatus, has been released by Rowe Radio Research Laboratory Co., 4201 Irving Park Boulevard, Chicago, Illinois. Copies are available, gratis.

* * *

A-F RESPONSE RECORDER DATA

A newly developed a-f response recorder is described in a four-page leaflet, published by Sound Apparatus Co., 150 West 46th Street, New York City. Copies are available to engineers.

H. C. L. JOHNSON NOW SYLVANIA RADIO TUBE AD MANAGER

H. C. L. Johnson has been named advertising manager of Hygrade Sylvania radio tube division. Until recently, P. S. Ellison, now director of advertising and sales promotion, had been manager of both renewal tube sales and advertising, and Mr. Johnson had been assistant advertising manager of the division.

* * *

RADIO CLUB HONORS LOU ALEXANDER

The Radio Club of America has elected Louis Alexander of Aerovox a Fellow.

* * *

ARBOR LIST OF OVER 650 PAPER TUBING SIZES

An arbor list of over 650 paper tube sizes for coil form and other uses is available from Paramount Paper Tube Company, 801 Glascow Ave., Fort Wayne, Ind.

Paramount tubes are available in square, round and rectangular shapes—kraft, fish, red rope, acetate or combination wound on automatic machines. They are said to have high-dielectrical characteristics and high-strength, and are kept to close tolerances.

For a copy of the arbor list, write to the company direct.

* * *

SHENK JOINS ERIE

Allen K. Shenk has joined Erie Resistor Corp., Erie, Pa., as assistant sales manager of the Electronic Division. Mr. Shenk was formerly vice-president of the W. S. Hill Company, Pittsburgh, Pa., where he was in charge of advertising and sales promotion activities for Erie Resistor since 1933.

* * *

16-INCH PRECISION LATHE CATALOG

An 8-page, file-size catalog illustrating and describing 16-inch toolroom lathes and 16-inch quick change gear lathes, attachments, accessories and tools for use with these lathes, has just been issued by the South Bend Lathe Works, South Bend, Ind.

* * *

NAVY HONORS BURTON BROWNE

For originating and placing a National advertising campaign for the Radar division of the Navy, Burton Browne, of Burton Browne, Inc., Chicago, Ill., has been awarded a Navy Proclamation of Gratitude. The citation was presented to Mr. Browne by Commander Philip R. Weaver, U. S. N. More than twenty-five publications are co-operating in the Radar enlistment campaign.

PLASTIC ALTERNATES FOR RUBBER

A semi-plastic material, made from polyvinl alcohol, has been pressed into service to release large quantities of rubber heretofore required to operate intricate machines used to build RCA radio tubes.

Time-honored custom has made rubber tubing standard for the flexible hoses needed to feed the fires with gas to moving burners from a fixed source. In addition, moulded rubber sections of almost pure gum have long been used as connectors between valves, traps, pumps and gauges in evacuating lines. A material known as "resistoflex," highly resistant to the many solvents that depreciated the rubber, has been placed in use by RCA to replace these rubber parts other than hoses. Washers, spacers, rollers and other machine parts have also been made of moulded or laminated "resistoflex" sheet stock, and machined to required dimensions, sometimes being frozen solid in liquid air to facilitate working.

Other uses have been rollers, aligning, devices, vibration dampeners, shock absorbers, power transmission drives, foot pedal coverings, sand blast lines and shields, metal belt pulley facings and many others. It is called for in ball mill cover gaskets, where it is subjected to solvents that destroyed the gaskets previously made of rubber. A small conveyor belt of the material has proved superior to a belt made of woven wire.

* * *

BOSSERT OF WARD LEONARD DEAD

John L. Bossert, sales engineer for the Ward Leonard Electric Co., Mount Vernon, New York, for the past 17 years, died recently at his home in that city.

* * *

DISC INFORMATION

A broadside, with data on glass base instantaneous recording blanks, has just been prepared by Gould-Moody Company, 395 Broadway, New York City. Copies available, free.

* * *

SCREW PRODUCTS CATALOG

Manufacturers Screw Products, 296T West Hubbard Street, Chicago, announce the publication of a screw products catalog, 96 pages and cover, in which all items conform to the revised suggested stock size lists, as per the maximum price regulation No. 147 of the Office of Price Administration, dated May 23, 1942.

The catalog contains not only list prices, but also complete technical data, giving weights and dimensions of various products. It features, for example, one entire section devoted exclusively to "AN" products for the Aviation Industry.

The book is supplied gratis, on request only, to any engineer or purchasing agent who will write for it on his business letterhead.

* * *

G.E. INDUSTRIAL CIRCUIT CONTROL SWITCHES BULLETIN

A new four-page bulletin illustrating and describing G. E. circuit control switches for industrial applications, has been prepared by the appliance and merchandise deartment at Bridgeport, Conn. Switches shown in the bulletin are for use in signalling equipment, communication appara-

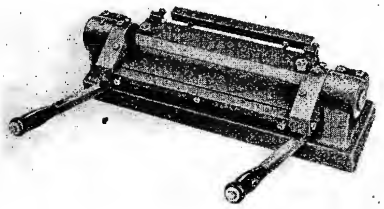
(*Continued on page 29*)

THE INDUSTRY OFFERS

METAL DUPLICATING UNITS

Improved DI-ACRO Models, namely, the new DI-ACRO Bender, and Brake, No. 2 series, are now being made by O'Neil-Irwing Mfg. Co., Minneapolis, Minn.

From 8 to 10 changes and improvements are said to be incorporated in each model, including increased weight and extended mechanical strength limits, offering greater rigidity, stability, ease of operation and higher material output. The DI-ACRO Bender, No. 2, is well adapted for forming all forms or round and irregular shaped tubes, as well as flat materials, required for Aircraft and Marine construction. The DI-ACRO Brake, No. 2, is also widely used for forming various types of special materials and synthetics as well as dielectrics and other substitutes, required in instrument, photographic, and optical manufacture.



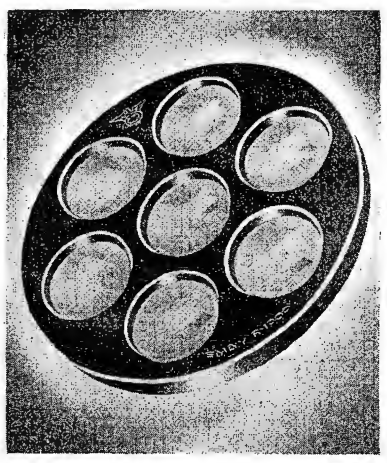
* * *

EMBY PHOTOELECTRIC CELLS

The Emby Products Co., 1800 W. Pico Blvd., Los Angeles, Calif., are now producing photoelectric cells of the self-generating type with an output in excess of 450 microamperes per lumen. These cells are manufactured in eight standard sizes with current outputs ranging up to 4,000 microamperes at 100-ft. candles.

Due to a special process developed by Emby engineers, the cells are said to have been made permanently stable and can withstand temperatures up to 70° centigrade. Spectral response of these cells extends from 240 millimicrons in the ultra violet into 720 millimicrons in infra-red.

A new "Giant" R-1000 photoelectric cell (illustrated below) has also been added to the Emby line. The new unit measures 7⅞ inches in diameter and has a current output of 4000 microamperes at 100-ft. candles. This cell has been developed for twilight switches, light barriers and other applications requiring a light sensitive element at a considerable distance from the control room.



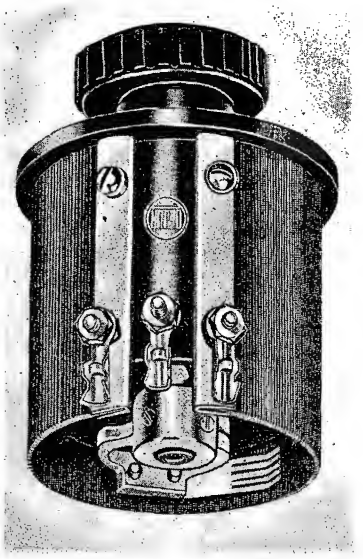
* * *

DE JUR-AMSCO RHEOSTATS

Rheostats in 6, 11, and 20 watt ratings with resistance ranges from 1 to 200,000 ohms are now being made by the De Jur-Amsco Corp., Shelton, Conn. These models, manufactured for the armed forces, include such features as tapped inserts moulded into the bakelite frame making it unnecessary to reach inside the unit for mounting necessary nuts.

These rheostats are said to be fully protected against all elements of corrosion, and have a maximum number of stops per degree of resistance winding. The contact wiper adjustment is so designed as to assure constant uniform pressure against winding without noisy circuit conditions.

A new and interesting folder on these units, has been published by DeJur, illustrating, by means of charts and specifications, the many rheostat features. Copies are for the asking.



* * *

INTERCOMMUNICATION SYSTEMS

A new line of intercommunicating equipment has been developed by Talk-a-Phone Mfg. Co., 1219 W. Van Buren St., Chicago. These systems include five station master, sub-station types.

Installation can be made to include all masters to a total of five, a master and a maximum of five sub-stations, or a combination of masters and sub-stations to a total of five units. Operation on all systems is on 110 volts a-c or d-c.

In the system having one master and a set of sub-stations known as the master selective type, the manufacturer says that stations can be placed at any distance up to 2,000 feet from each other and volume can be adjusted by means of the volume control. This system also has the exclusive "Silent Feature." Also available is the combination master system which permits the use of two or more masters in combination with sub-stations. Sub-stations may be called by either master.

TANDEM TIMERS

The "Tandem Timer," a timing device for laboratory and factory use, is now being made by Industrial Timer Corp., 113 Edison Place, Newark, N. J.

The "Tandem Timer" is essentially a control unit with two individual and variable plug-in type timing elements. With the timing elements adjusted to their correct respective time intervals, each cycle of operation will follow the other continuously in regular sequence. When the timer dials are once set at the time interval desired, further adjustments are unnecessary until a new sequence is required. The automatic reset features of the "Tandem Timer" makes a continuous, as well as a single cycle of operation possible. Plugging in of different timing elements is accomplished in a matter of seconds.

The control cabinet measures 8½ inches by 8½ inches by 5 inches and contains the "ON" and "OFF" toggle switch, repeat and single cycle toggle switch, single cycle start push-button switch, pilot lamps, receptacles, and sockets into which are plugged the two timing elements which control the single pole double throw load relays. The contact circuits of the load relays are unpowered so that they may be powered with the particular voltage and current necessary for test or production requirement. The load relay contacts are rated at 110 volts, 10 amperes a-c.

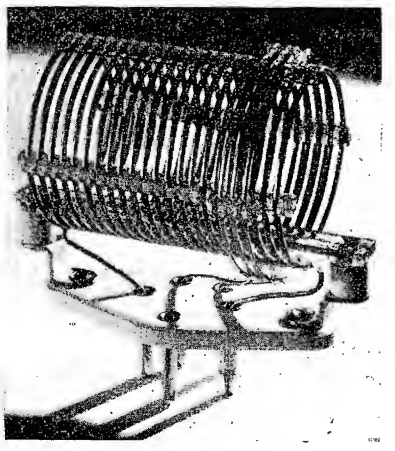
The timing elements are synchronous motor driven, automatic resetting timers, contained in a formed steel box which measures 5 inches by 5 inches by 3 inches.

* * *

LUMARITH ON COILS

Lumarith (cellulose acetate) is now being used by Barker & Williamson in their induction coils, at four different radial points for insulation. All sizes use Lumarith for insulation; these sizes range from 1⅝ inches in diameter by 2⅛ inches long,

(*Continued on page 33*)



VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President — RCA BUILDING, 30 Rockefeller Plaza, New York, N. Y. — GEORGE H. CLARK, Secretary

HONOLULU

CENSORSHIP does have a heart, after all, and so the following abstract may now be given from a letter sent by George Street, our genial chairman in Honolulu, who remembers Pearl Harbor if anyone does!:

"Jack Balch, chairman of the board of the Mutual Telephone Company, recently asked me how much a life membership would be, but concluded that he would not live more than five years so sent ten dollars in dues instead. (It's $50.00, Jack, and we'll credit you with the ten-spot.—W.J.M.)

"I have seen Colonel Woolverton a couple of times since the 'Blitz' and reminded him that I received my first 'Ham' license from him in the Customs House in San Francisco, 31 years ago.

"Honolulu is still here, of course, and probably in the mind's eye of all of you old guys you see this overworked, overburdened and broken down or sunning himself on a white, sandy beach with a dusky maiden playing an ukelele, underneath a cocoanut tree. Where have I seen that picture before? Probably in the same magazine where you saw it."

George left New York on May 28, 1935, to become manager of the Hawaiian district office. He relinquished a job as manager of the RCA Communications office in the RCA Building, not knowing a cinch when he had one. His excuse was that:

"Mr. Rockefeller's cellar has got my goat;
No more forced air goes down my throat."

However, he knows better now, as his letter goes on to say:

"Sure would be a treat to hang around the counter in cell 64 in Mr. Rockefeller's cellar and have a decent lunch in the Oyster Bar for a change. You know, it takes a long time to find it out, but I have discovered that work in the Far West is just the same as work anywhere else!"

CHAPTERS

MEMO from the secretary to all Chapters: Many letters are coming in from the various military and civil government sections, with reference to men who claim to be members of VWOA and who are applying for positions. In several cases the New York records do not show the name in question, but in every case the application had been filed in Chicago, or some other outlying chapter, where the applicant may well have been a member. This brings up a very important point. ALL applications for membership, and the dues accompanying, are supposed to be sent to the New York parent section, so that (1) the accepted applicant will receive a copy of COMMUNICATIONS for a year, and (2) will be listed in the official record. One-fourth of the dues is at once refunded for the local treasury. However, this procedure is not lived up to by all, and as a result some paid-up member may give us as a reference, only to have this repudiated by the New York office. Appeal . . . every chapter secretary . . . follow the above procedure as laid down by our charter, and also send at once a full list of all paid-up members.—*G. H. Clark.*

REMINISCING

MORE memories from old Bill Fitzpatrick, charter member, VWOA:

"Printing the Ocean Wireless News with information cribbed from ancient newspapers. . . . Sending green kids down to the engine room for the key to the storage batteries . . . or for a pail of steam . . . Standing on the corner of Broadway and Forty-second Street with Tom Stevens, waiting. . . . How many old timers remember Lena Michelsen and Florence Levy? . . . G. W. "Johnny" Johnstone, whom many oldsters will recall as the man who always obligated at the piano during VWOA reunions, has completed the circle. . . NBC to WOR and back to the Blue Network. . . E. N. Pickerill once operated a de Forest station on Pike's Peak, 14,147 feet in the air. . . . Arthur Isbell must think now and then in his home in San Francisco of the days when he sat in as operator in Honolulu at the opening of the first wireless communication between the Islands and the Pacific mainland.

"When inefficiency triumphed. Skippers of the old days didn't like to have their traditional freedom interfered with by the new-fangled wireless. Said one: "I want a poor operator. He doesn't bother me much. A good operator gets too many orders from the boss for me." J. M. Baskerville, an old-timer, was at first the type that the Old Man wanted. One night he got warning of a storm of extraordinary intensity. The Captain heard his story, squinted at the heavens, and merely said "Bunk." Two days later they contacted another ship and changed course to meet her. Then only did the skipper hear that 'the weather last night was so rough that one pilot was drowned, and the other pilot couldn't reach his pilot boat, so will you take him?' Wireless was vindicated!"

OBITUARY

With deep sorrow, we announce the death of Commander Malcolm P. Hanson, former chief radio engineer on Admiral Richard E. Byrd's 1928-30 Antarctic expedition.

Commander Hanson, in recognition of the outstanding work he had done with the expedition, was awarded the Veteran Wireless Operator's Association gold medal. Hanson was 11,000 miles away from the site of the ceremony—at the Radio World's Fair at Madison Square Garden in New York—but heard the citation by radio and wirelessed his thanks.

Hanson, who won his Navy commission in 1919, had had ample experience with equipping polar expeditions with radio prior to his trip to the Antarctic. He assisted in setting up radio equipment for the Navy-MacMillan expedition of 1925 and for the Wilkins Detroit and Byrd Arctic expeditions the following year. Hanson also arranged the radio equipment in Admiral Byrd's trans-Atlantic plane in 1927.

ANNIVERSARY

Our congratulations to Dr. Lee de Forest, who on August 26, will celebrate his 69th birthday.

BOOK TALK . . .

FUNDAMENTALS OF RADIO

Edited by William L. Everitt, Professor of Electrical Engineering, Ohio State University (now Director of Operational Research Section, Signal Corps): Authored by Edward C. Jordan, Instructor in Electrical Engineering, Ohio State; Paul H. Nelson, Assistant Professor of Electrical Engineering, University of Connecticut; William C. Osterbrock, Professor of Electrical Engineering, University of Cincinnati; Fred H. Pumphrey, Professor of Electrical Engineering, Rutgers (now with Signal Corps); and Lynne C. Smeby, Director of Engineering for NAB (now with Signal Corps). . . . 400 pp. . . . New York: Prentice-Hall, Inc. . . . $5.00.

This book, written by top-flight specialists, presents basic data, essential to all forms of radio work, both civil and military.

Contents include a review of mathematics of radio, a-c and d-c circuits, electronic principles, rectified power supplies, sound and its electrical transmission, audio amplifiers, vacuum tube instruments, electro-magnetic waves, transmission of signals by radio, r-f amplifiers and detectors, a-m and f-m receivers and transmitters, etc.

Actually the book follows the instruction outline recommended by the National Association of Broadcasters, as well as the specifications on training given by the Signal Corps.

The book has not been written for engineers but rather for technicians who must know how to maintain and operate all types of radio apparatus. In this respect it is complete and authoritative.—O. R.

• • •

DEFINITIONS OF ELECTRICAL TERMS

Sponsored by American Institute of Electrical Engineers. . . . 300 pp. . . . New York: AIEE Headquarters. . . . $1.00.

This volume of definitions is an unusual contribution to the electrical art in America. For the first time definitions of the important terms common to all branches of the art as well as those specifically related to each of the various branches have been assembled and printed under one cover.

This glossary is the result of more than twelve years' work of a sectional committee of 46 members having 18 subcommittees drawn from available specialists. More than 300 individuals have given material assistance and many others have assisted in specific instances. The 34 organizations represented on this sectional committee in-

clude the national engineering, scientific and professional societies, trade associations, government departments and miscellaneous groups.

Included are chapters or groups, as the book describes them, on electrocommunication, electronics, switching equipment, lightning and lightning rods, instruments, transformers, etc. In the electrocommunication group are sections devoted to transmission (radio and wire), television, broadcasting, alarm systems, patrol systems, etc. The electronics group covers vacuum tubes, gas tubes, photo-tubes, cathode ray tubes, etc.

Among those who served on the committees devoted to radio and electronics were such personalities as A. F. Van Dyck, Haraden Pratt, O. W. Pike, B. E. Shackelford, F. A. Wolf and W. Wilson.

For reference work or for general reading, for student and engineer, this book is highly recommended.—L. W.

• • •

NEWS BRIEFS

(*Continued from page* 25)

tus, instrument panel boards, utility lighting systems, specialized lighting equipment, aircraft circuit control systems, etc.

The bulletin shows 26 toggle and push-button switches.

Wiring diagrams of all switches, and specifications of assembly parts are given. Copies of the bulletin are available on request.

* * *

CORNELL-DUBILIER TAKES THIRD PLANT

A new plant at Providence, R. I., has been placed in operation by Cornell-Dubilier Electric Corp. This new unit will process raw materials for the older Cornell-Dubilier plants.

* * *

DI-ACRO CATALOG

A revised edition of the Di-Acro Catalog No. 42-2 has been released by the O'Neil-Irwin Mfg. Co., Minneapolis, Minn.

Two new and additional Di-Acro products, namely, the Di-Acro Brake, No. 3, of 18-inch capacity, and the Di-Acro Shear, No. 2, of 9-inch capacity, have been included in this new edition.

* * *

BERYLLIUM COPPER FUSE CLIP FOLDER

A 4-page folder on the new Littlefuse Beryllium Copper Fuse Clips and Screw Terminals, has been prepared by Littlefuse, Inc., 4757 Ravenswood Ave., Chicago, Ill.

This folder has blueprint style drawings, and many charts. The treatment of the use of Beryllium copper for these purposes is said to be the first ever published.

* * *

SMPE FALL MEETING IN N. Y.

Plans for a 3-day meeting composed of eight technical sessions beginning October 27, in New York, has been completed by

(*Continued on page* 31)

MOTOR AND GENERATOR MAINTENANCE

(*Continued from page 22*)

pull. Sand only until the curve of the brushes is the same as that of the commutator over the whole end of the brush. Carefully blow out all dust from the machine and securely fasten brush pigtails to their holders before starting the machine.

Care of Commutator

Inspect commutators for color and condition. They should be clean, smooth, and have a polished-brown color on the brush contact area. A bluish color indicates overheating of the commutator.

Dirty or oily commutators should be cleaned with a lintless cloth. Roughness of the commutator should be removed by sandpapering or stoning while running the machine at no-load. In the case of a generator, the sanding should be done with no field excitation on the generator. Never use emery cloth or an emery stone on a commutator as emery is conducting. The proper stone is known to the trade as a commutator stone and is essentially a rectangular piece of grindstone. If sandpaper is used, it should be wrapped partly around a wood block in order to present a straight, flat surface. Place the stone or sandpaper against the rotating commutator with moderate pressure and move it back and forth across the commutator surface. *Use care not to come in contact with live parts.*

If the commutator is very rough the armature should be removed and the commutator turned down in a lathe. When this is done, it is usually necessary to undercut the insulation between commutator segments slightly. After turning down a commutator, its brushes should be refitted as previously described for new brushes. This is not necessary after light sanding or stoning.

Never put oil or other lubricants on a commutator. Proper brushes give the commutator all the lubrication required to prevent undue wear and to build up a smooth operating glazed surface on the copper.

Care of Insulation

Proper care of insulation is an important item in a maintenance program. Dust, oil or moisture should not be allowed to accumulate on the insulation of a motor or generator.

Motors and generators should always be stored in a dry, clean place until ready for installation. If necessary, heat should be supplied to protect against alternate freezing and thawing. Machines that have been long in transit in a moist atmosphere, or idle for an extended period, should be thoroughly dried out before being placed in service. If possible, machines should be kept warm at all times to prevent moisture from the air condensing on them.

Drying-Out of Insulation

The most effective method of drying out machines that have become wet by accident or because of condensation is to pass current through their windings. This method is particularly recommended for high-voltage generators and motors which have comparatively thick insulation. The voltage used should be low enough to be safe for the winding in its moist condition. Temperature of the windings should not exceed 90° C for Class A insulation (most generally used). Place thermometers on the windings to make certain they are uniformly heated and that their temperature does not exceed 90° C.

Another method is to blow warm air (temperature not over 100° C), through the machine. This can be done by setting a fan to blow air across the front of a "glow heater' 'and then into one end of the motor or generator. Smaller machines can be placed in temperature controlled ovens with the temperature set at 90° C. or less.

Insulation Resistance Tests

The time required for complete drying-out depends considerably on the size and voltage rating of the machine. Insulation resistance measurements should be taken at intervals of two to four hours until a fairly constant value is reached. These tests are a good indication of the general condition of the insulation and its ability to stand the operating voltage.

The insulation resistance should at least equal the recommended AIEE standard, which is:

$$\text{Megohms} = \frac{\text{Rating voltage of machine}}{\left(\frac{\text{rating in kva}}{100} + 1000\right)}$$

Insulation resistance tests should also be made before a high potential test, to determine whether the insulation is ready for such a test, and afterwards to make certain that the high-potential has not injured the insulation.

High-Potential Tests

It is desirable to make high-potential tests on a machine after drying out or repairing in order to check the dielectric strength of its insulation. New windings should successfully withstand a high-potential test of twice normal voltage plus 1000 volts for one minute. High-potential tests on machines that have been in operation for some time should be made *after thorough cleaning and drying* with the voltage limited to about 150 per cent of normal voltage.

Small high-potential testing sets are available for this work and are so constructed that very little damage will result to the machine from a breakdown during test.

Cleaning

A systematic and periodic cleaning of motors and generators is necessary to insure best operation and long life. The amount of cleaning and its frequency depends largely upon the type of machine and its operating conditions.

Open fan motors and unprotected machines operating in rather dusty places should receive a partial cleaning every week. This consists of blowing out dust and dirt from the windings and interior of the machine with dry, compressed air (about 25 lbs. per sq. in. pressure or less). Suction cleaning with a high-vacuum cleaner is greatly pre-

(*Continued on page 36*)

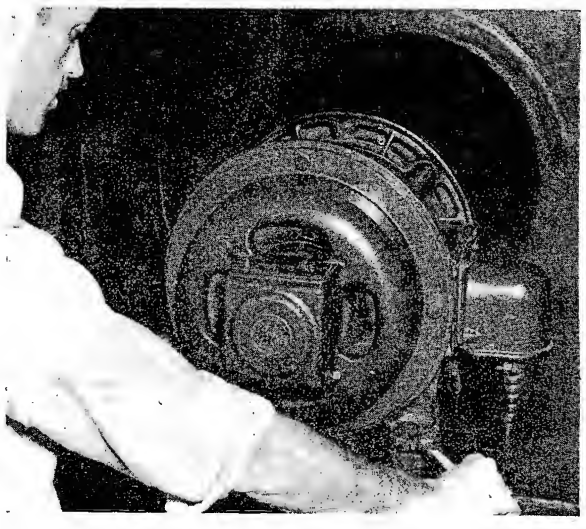


Figure 7
Tightening the motor foot bolts to guard against vibration. This step, which might appear minor, is a very important one, for vibration can throw plenty of punishment on the motor and decreases its life considerably.

(*Continued from page 29*)

the officers of the Society of Motion Picture Engineers.

The gathering is the 52nd semi-annual meeting of the society, and will be in charge of William C. Kunzmann, of Cleveland, convention vice president. The meeting is subject to cancellation if such action is later deemed advisable in the national interest.

* * *

PAPER TUBULAR DATA

Over a hundred sizes and types of oil-impregnated and oil-filled paper capacitors in metal tubes, are described and illustrated in the latest 48-page Solar catalog on paper capacitors.

A feature of these capacitors is said to be high insulation resistance, recommending their use as coupling capacitors.

Copies of the catalog are available from Solar Mfg. Corp., Bayonne, N. J.

* * *

W. A. COOGAN RE-APPOINTED TO RMA POST

W. A. Coogan, foreign sales manager of Hygrade Sylvania Corporation, was reappointed chairman of the Radio Manufacturers Association Export Committee for the coming year.

* * *

SOUND AIDS RAILROADS IN WAR EFFORT

Many applications of sound equipment are to be found in the installations made during the past 60 days, according to George Ewald, RCA commercial sound division manager.

The Illinois Central is using sound to direct operations in one of its most important classification yards, and has installed complete radio and paging facilities on its new "Panama Limited." The Michigan Central, and Chicago-Northwestern Railroad have installed sound. The Pennsylvania is putting special sound equipment in 40 coaches.

Among other RCA sound installations completed during the period, Mr. Ewald listed a "military" mobile public address system placed at the Tank Destroyer School in Texas.

* * *

RMA ELECTS M. F. BALCOM

M. F. Balcom, vice-president and general manager of the Radio Tube Division, Hygrade Sylvania Corporation, was elected vice-president and director of RMA as well as chairman of the radio tube division, at the recent meeting in Chicago.

* * *

BAHR NAMED G.E. PURCHASING AGENT

R. J. Bahr has been named purchasing agent for the General Electric Radio, Television, and Electronics Department and will have his headquarters at Schenectady. Mr. Bahr will supervise the purchasing activities of all divisions of the de-

(*Continued on page 32*)

(*Continued from page* 31)

partment. He was formerly buyer for the receiver division of the department, at Bridgeport.

* * *

JANETTE'S NEW CATALOG

An 8-page catalogue covering data on rotary converters and converters, has been released by Janette Mfg. Co., 556 West Monroe St., Chicago, Ill.

* * *

OFFICIALS VISIT NEW NATIONAL UNION PLANT

Major Kenneth D. Johnson, representing the Signal Corps of the United States Army, as the guest of honor, and officials of the National Union Radio Corporation recently made an inspection tour of the new National Union plant now nearing completion at Lansdale.

Among the officials in the party, in addition to Major Johnson, were S. W. Muldowny, president of National Union; Henry A. Hutchins, in charge of construction of the new plant; O. H. Brewster, director of enginering; E. O. Sandstrom, assistant treasurer, and Elwood Schafer, manager of the cathode ray tube division.

* * *

SUPPRESSOR DATA SHEET

A new data sheet giving descriptions and characteristics of Erie Suppressors has been issued by Erie Resistor Corporation, 640 West 12th St., Erie, Pa. Charts showing suppression efficiency and life tests are included.

* * *

G.E. TRAINS SIGNAL CORPS MEN

Forty-eight radio men were graduated recently from an eight-week G. E. course in latest radio developments, and were given diplomas by Dr. W. R. G. Baker, G. E. vice-president.

Twenty-three of the graduates were civilian engineers attached to the U. S. Army Signal Corps, and 25 were G. E. employees. The course was in charge of G. W. Fyler, assisted by R. D. Griffith and B. J. Lawrence.

* * *

ZANGARO NBC COMMUNICATIONS SUPERVISOR

Louis A. Zangaro has been appointed national supervisor of the Communications Division of the National Broadcasting Company Traffic Department.

Zangaro assumes the post vacated by Willard Delano Whitfield, who is on military leave in the U. S. Coast Guard, in the radio communications branch.

* * *

SANDRETTO APPOINTED MAJOR

P. C. Sandretto, superintendent of United Air Lines' communications laboratory in Chicago, has become a major in the Communications Directorate of the Army Air Forces at Washington.

As head of United's laboratory, Sandretto has participated in many of the outstanding aircraft radio developments which have become standard on the nation's airlines.

Sandretto is the author of "Principles of Aeronautical Radio Engineering" and numerous technical magazine articles, many of which have appeared in COMMUNICATIONS.

* * *

PRICE REDUCTION SCHEDULE

The Elastic Stop Nut Corporation, 2330 Vauxhall Road, Union, New Jersey, has announced reductions in prices of 415 items of anchor, gang-channel, and instrument-mounting types of elastic stop nuts in their latest 8-page bulletin.

The bulletin also contains cross sectional diagrams. Copies are available free.

* * *

CONTRACT DATA

By sending ten cents to the Superintendent of Documents, Washington, D. C., you can get a very timely and informative booklet containing a thorough explanation of principles for determination of costs under government contracts.

* * *

AMPERITE REGULATORS

Amperite Company, 561 Broadway, New York City, announces a new line of battery current and voltage regulators, which are claimed to cut battery voltage fluctuation from approximately 50% to 2%. They are hermetically sealed and said to be unaffected by altitude, ambient temperature or humidity.

* * *

ROWE APPOINTS McCAFFRY

J. A. McCaffry, 610 Blaine St., Detroit, Michigan, has been appointed technical sales representative for the Detroit area and State of Michigan for Rowe Radio Research Laboratory Co., Chicago, Ill.

THE INDUSTRY OFFERS . . . —

(*Continued from page 26*)

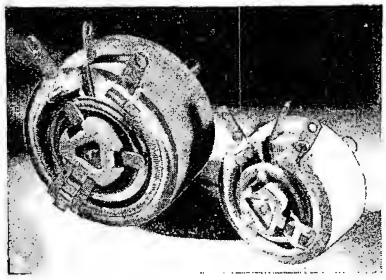
up to 1 foot in diameter by 2 feet long. Barker & Williamson are at Upper Darby, Pa. Lumarith is a product of Celanese Celluloid Corporation, N. Y. C.

* * *

50-WATT POWER RHEOSTAT

An extra heavy duty power rheostat, handling up to 50 watts, has been developed by Clarostat Mfg. Co., Inc., 285-7 N. 6th Street, Brooklyn, N. Y.

This new 50-watt rheostat is virtually identical to the previously introduced 25-watt unit, except for its larger size. The selected resistance wire is wound on an insulated metal core which distributes the heat at intermediate rotational settings. The resistance element is firmly imbedded in a ceramic housing with an inorganic cement, resulting in a solid thermal mass. A graphited-copper contact shoe rides the collector ring and the winding, assuring two positive sliding contacts. Contact pressure is provided by a helical spring, concentrically mounted about shaft whose action is evenly distributed by use of a tripod-type contact carrier. The contact is insulated from the metal shaft by a center ceramic insulator, thus providing a "dead" shaft and mounting bushing. Available in any resistance value up to and including 10,000 ohms.



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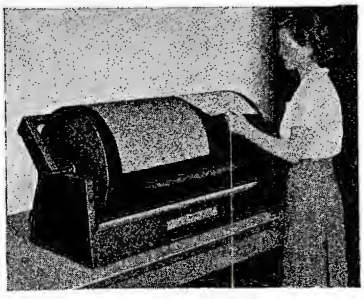
BLUE PRINT DRYER

The Warren Electric Appliance Co., Warren, Penn., announced an inexpensive new Blue Print Dryer. This new Blue Print Dryer is said to permit the drying of blue prints on the spot.

This new item is known as the Weaco Blue Print Dryer, and is made to accommodate standard 30-inch blueprint paper in lengths up to 32 inches. The chromium plated drum measures 34x18 inches in diameter, and has a drying surface of 32x52 inches. The manufacturer states that it will dry a blue print in approxi-



(*Continued from page* 33)

mately five minutes.

Another feature is said to be its economy. It uses only 700 watts on 115 volts, either a-c or d-c operation.

* * *

IMPROVED DUREZ 11540 PLASTIC

Durez 11540, a general-purpose phenolic molding compound, is said by Durez Plastics & Chemicals, Inc., of North Tonawanda, N. Y., to have been made adaptable to many new uses through a minor revision in its formulation. It has already been adopted for several war production parts requiring military approval. Durez 11540 has slightly higher impact strength and greater water resistance than former top-grade general-purpose materials. It is said to deliver excellent surface finish. Field communication equipment which must withstand hard usage, as well as instrument cases, housings, and parts are now being molded of this material.

* * *

NEW FOUR-POLE RELAY CONTROL DEVICES

A new four-pole relay has been added to the line of General Electric control devices for aircraft applications. Features of the new relay are said to be light weight, permanence of contact position and assurance of operation under severe vibration conditions, and operation at high altitudes at rated current.

The relay has a maximum continuous current rating of 10 amperes at 12 or 24 volts d-c and a maximum make or break current rating of 50 amperes at 12 or 24 volts d-c. The normally open contacts have a tip travel of 3/64 inch. Coil wattage is 1.80. The relay weighs .281 pound.

Dimensions are: length, 2½ in.; width, 1 5/32 in.; and height, 1 25/32 in.

* * *

PHOTOELECTRIC PROTECTION SYSTEMS

A photoelectric control, with a light source projecting a practically invisible light beam for distances of 350 to 700 feet, is being made by Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.

The control is provided with a latching unit including a push button station which may be located in the gate house, office, or other convenient point. This serves to latch an alarm in operation once the light beam has been momentarily broken until the reset button is operated. The relay contacts are pure silver and will handle 15

(*Continued from page* 34)

amps. a-c and 8 amps. d-c. Control operates from 115 volts a-c source of supply.

* * *

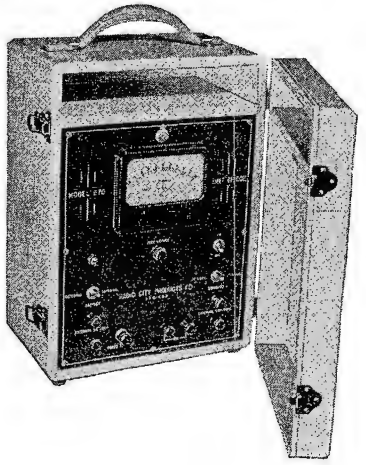
RCP ELECTRONIC LIMIT BRIDGE

An Electronic Limit Bridge is now being produced by Radio City Products Co., 127 W. 26th St., New York City.

This instrument, known as Model 670, features a dial calibrated from zero center to ten percent deviation on either side. With each main division on the dial indicating one-half of one percent, fractional divisions showing deviations of one-tenth of one percent can be read quickly. Comparision is made against a predetermined internal standard of any arbitrary value selected. While this is supplied as part of the bridge, provision is also made for using any other value of resistance desired by switching to "External Standard" and connecting the new standard value to the corresponding terminals.

Component resistors are said to be accurate to one-tenth of one percent, and the indicating meter is a 4½-inch galvanometer having a sensitivity of 25-0-25 microamperes.

The unit is battery operated and completely self-contained in a natural finish solid oak carrying case.



* * *

GROOVE EMBOSSING RECORDER

Incorporating the sound groove embossing system, The SoundScriber Corporation, 82 Audubon Street, New Haven, Connecticut, has developed several recorders, for permanent and portable use.

The SoundScriber recorder is a compact disc recorder employing a 7" diameter turntable operated at a constant angular speed of 33 r. p. m. Recording is done by embossing the sound groove at 200 grooves per inch, giving 15 minutes recording on each side of the disc. The recorder is equipped with a playback and built-in speaker. The standard recorder is designed for desk use with separate microphone. Recording discs are a vinyl plastic, .010" thick.

The recording head is of a patented electro-magnetic design with high cross-section armature, stiff metallic torsion. Embossing stylus is diamond (permanent). Embossing pressure 5-6 ounces produced by dead weight of head. Head mounted by spring hinge to feed arm. Alnico magnet.

The pick-up is also of patented design, of the oil damped, moving coil type.

MOTOR AND GENERATOR MAINTENANCE

(*Continued from page 30*)

ferred for this purpose if one is available. Make certain to blow out the air ducts on larger d-c machines so that ventilating air can pass through as intended.

For a thorough cleaning, the end-shields and armature (or rotor) of the machine should be removed. Dry dust and dirt may be blown off, but care must be taken to direct the air so that dust will not be pocketed in corners or blind-spots. Heavy dirt or grease should first be removed with a stiff brush, wooden or fiber scrapers, and cloths.

Grease, oil and sticky dirt can be easily removed from insulation by applying cleaning liquids such as carbon tetrachloride, naphtha or gasoline. Caution must be exercised not to soak the insulation with the liquid.

If the insulation on the windings appears to have deteriorated or "checked," a high-grade insulating varnish should be applied. It is highly desirable to heat the windings to drive off all moisture before applying varnish. The varnish should be applied by spraying or brushing while the windings are still warm. For small stators, field coils and armatures, it is best to dip the windings into the varnish and clean off the adjacent metal parts afterwards with a solvent of the varnish.

Best results are obtained by baking the varnished parts at the temperature and for a length of time recommended by the varnish manufacturer. This is often from 3 to 7 hours at 100° C. If the machine must be put back into service quickly, or if facilities are not available for baking, fairly good results will be obtained by applying one of the quick-drying varnishes which dry in a few hours at ordinary room temperatures.

General Overhauling

Periodic overhauling will be found beneficial in avoiding breakdowns and increasing the useful life of a machine. Motors and generators should be given a general overhauling about every five years. This consists of a complete disassembly of the machine, thorough cleaning, critical inspection of clearances and parts, and repair or replacement of damaged or worn parts.

Before disassembly, check the air gap between rotor and stator (or armature and pole pieces for a d-c machine) with a feeler gauge for uniformity. Smaller clearance at the bottom generally indicates worn bearings.

Measuring Bearings

After disassembly, bearings and journals of sleeve-bearing machines should be measured to determine if new bearing linings are required. Oil grooves in bearing linings should be cleaned if clogged. Ball bearings should be inspected after cleaning for excessive looseness and wear. The presence of foreign particles, flattened or chipped balls, or cracked races in ball bearings can generally be detected by slowly rotating the cleaned and dry bearing by hand.

Checking Waste Packing

The waste packing should be removed from waste-packed bearings and rearranged or replaced so that any glaze on the wool is removed from its point of contact with the shaft. The wool should be replaced if it contains a gummy deposit. All lubricants should be cleaned out of the bearings and a fresh supply put in when the machine is reassembled.

Rust

Any rust on the shaft, stator, bore, armature and pole pieces should be re-

(*Continued on page 39*)

Type	H.P. Ratings	Speed Regulation	Speed Control	Starting Torque	Pull-Out Torque	Applications in Radio Apparatus
General - purpose squirrel cage	¼ to 200	3% for large to 5% for small sizes	None, except for multi-speed types	200% of full-load for 2-pole to 105% for 16-pole designs	200% of full-load	Constant-speed service where starting torque is not excessive. Fans, blowers, rotary compressors, centrifugal pumps, generators
Full-voltage starting high stg. torque low stg. current squirrel cage.	1 to 150	3% for large to 6% for small sizes.	None, except for multi-speed designs	250% of full-load for high-speed to 200% for low-speed designs	200% of full-load	Constant-speed service where fairly high starting torque is required with starting current of about 400% of full load. Reciprocating pumps and compressors
Full-voltage, starting, high stg. torque, high-slip squirrel cage.	½ to 150	7% to 12%	None, except for multi-speed designs	300% to 315% of full-load, depending upon speed and rotor resistance	300%. Will usually not stall until loaded to its maximum torque which occurs at standstill	Constant-speed service and high starting torque and for taking high-peak loads with or without flywheels. Generally not employed in radio apparatus
Wound, rotor, external resistance starting.	½ to several thousand	With rotor rings short-circuited, about 3% for large to 5% for small sizes	Speed can be reduced to 50% of normal by rotor resistance.	Up to 300% depending upon external resistance in rotor circuit and how distributed	200% when rotor rings are short-circuited	Where high-starting torque with low-starting current or where limited speed control is required. Usually not employed in radio apparatus

Figure 8
Characteristics and applications of polyphase a-c motors.

PROGRAM FAILURE ALARM

(*Continued from page 6*)

rent. This alarm current is plotted against percentage of modulation in Figure 3 for a 5 milliampere rectified carrier. The rate of decay of the current for the 20, 46, and 76, second switch positions is shown in Figure 5. From these curves it can be seen that for the 20-second time delay any percentage modulation above 25% will add less than two seconds to the delay time. Althougs the curve does not show it, 5% modulation will hold the meter at 4 ma and this will decrease the delay time error by only 3 seconds.

Plotting Frequency

In Figure 4, the frequency is plotted against the relay current, showing an increase of .6 ma at 10,000 cycles, with an error of less than one second for the 20-second time delay. The instrument can, therefore, be considered independent of frequency and percentage modulation.

The program alarm is built on a standard 8½ by 19 inch relay rack panel and is a-c operated with a self-contained power supply. The input to the unit requires approximately the same r-f voltage as the standard modulation monitor and the two units can, therefore, be connected in parallel.

Operation of Relay

The device in operation is adjusted for a carrier current of 5 ma, which holds the relay RL_1 closed and at the same time insures correct time-delay action, since the unit was calibrated at this value. No other adjustment is necessary.

Fool-Proof Circuit

The alarm circuit is fool-proof, as the device monitors its own operation and cannot become defective in operation without an alarm indication. The time delay action can be tested at any time with the push button switch (SW_2).

Installation of KILO-KFJM

In operation at radio station KILO-KFJM the 20-second time-delay has been found satisfactory for station monitoring even on network programs. Ordinarily the station break announcement, if spaced properly, will prevent the alarm sounding during the network pause. This unit relieves the transmitter operator of the necessity of aurally monitoring the program and at the same time indicates to the announcer any transmission failure.

(*Continued from page* 36)

moved with fine sandpaper. After cleaning and drying, these parts should be protected from moisture by applying a thin coat of high-grade clear varnish or lacquer.

Inspection

All soldered joints and binding cords should be inspected and repaired if loose or weak. Check that the top sticks in stator and armature punchings are wedged in tightly. Field coils on d-c machines should be carefully wedged if loose on their pole pieces. Make certain that all leads to brush holders and field coils are tied down or otherwise supported such that they will not come in contact with the commutator and armature.

TELEVISION PRACTICES

(*Continued from page* 11)

ing of 100 or more as reflected from one's hand to a Weston photometer of the usual type used in amateur and professional photography. The light should be brilliant white, as secured by using C. P. (color photography) motion picture production incandescent lamps, largest photoflood No. 4, or quiet motion picture production arc lamps. Provision for several hundred amperes of electric current must be made for lighting an area the size of the average theatre stage. If direct current is available, this should be supplied rather than alternating current.

Other data on this sheet covers facilities for television equipment. The power circuit, for instance, must be of sixty cycles, 115 volts, single phase, 30 amperes on a line which is not used for any other purposes during tests and broadcasts. This power is to be available at the Control equipment location.

Cameras are also discussed in the Work Sheet. Cameras required a space 5 ft. square each. Camera No. 1 may be a maximum of 300 ft. from the control equipment; Camera No. 2, a maximum of 30 ft.

The antenna requirements are also discussed in this "sheet." A twenty-four ft. duraluminum pole is to be erected as high as possible with an unobstructed line of sight to the Mt. Lee, Hollywood, preferably close to the control equipment and not over 400 feet therefrom.

Other data on this "sheet," includes proposed locations, preliminary tests, nature of pickups, etc.

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Assembled from Laboratory Parts

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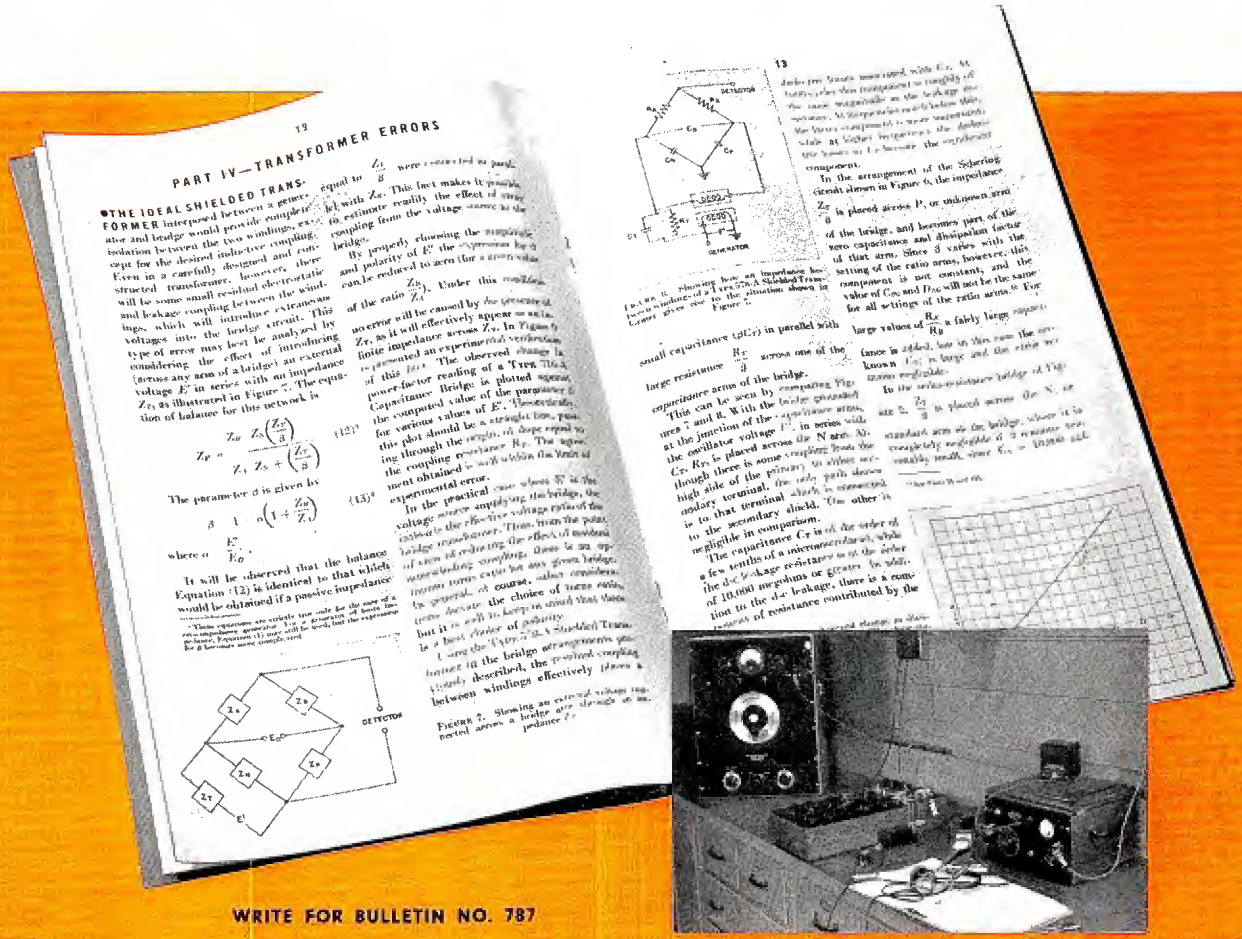
How to set up and use impedance bridges was discussed in a series of articles entitled "Impedance Bridges Assembled from Laboratory Parts," which appeared in the General Radio *Experimenter*. These articles have been reprinted in the 24-page booklet illustrated below. Much information not usually found in text books is included, as for instance, how to choose the best bridge circuit for a given type of measurement, and how to determine the magnitude of residual impedance errors.

A copy is yours for the asking. This booklet should be especially useful to students. Copies are available for educational institutions.



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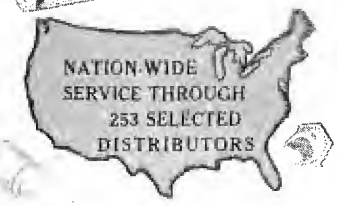

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